NASA Apollo Program
Historical Information

NASA
Apollo
Saturn V Rocket
Summary Information

Source:
“Saturn V Flight Manual SA-506 (Apollo 11)”

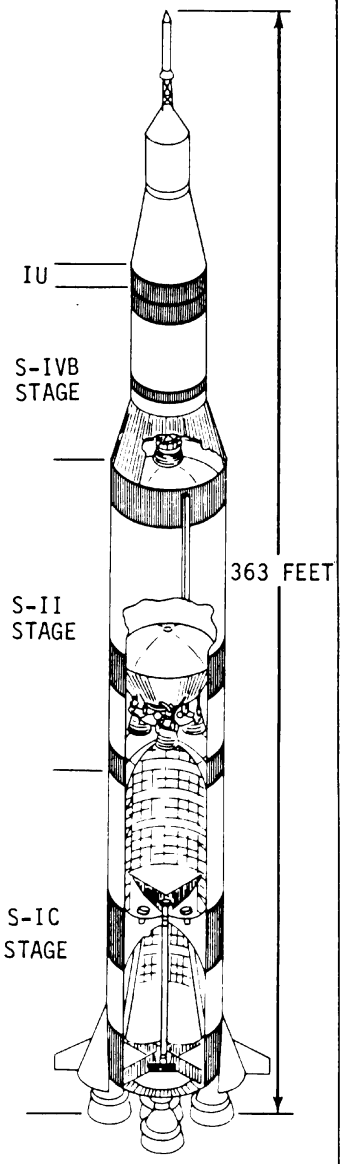
SATURN V LAUNCH VEHICLE

SOLID ULLAGE ROCKET AND RETROROCKET SUMMARY				
STAGE	TYPE	QUANTITY	NOMINAL THRUST AND DURATION	PROPELLANT GRAIN WEIGHT
S-IC	RETROROCKET	8	75,800 POUNDS * 0.541 SECONDS	278.0 POUNDS
S-II	ULLAGE	4	23,000 POUNDS † 3.75 SECONDS	336.0 POUNDS
	RETROROCKET	4	34,810 POUNDS ‡ 1.52 SECONDS	268.2 POUNDS
S-IVB	ULLAGE	2	3,390 POUNDS ** 3.87 SECONDS	58.8 POUNDS

ENGINE DATA					
STAGE	QTY	ENGINE MODEL	NOMINAL THRUST EACH	NOMINAL THRUST TOTAL	BURN TIME
S-IC	5	F-1	1,530,000	7,650,000 ††	167.3 SEC
S-II	5	J-2	230,000	1,150,000	382.4 SEC
S-IVB	1	J-2	232,000	232,000	TO BE DETERMINED

STAGE DIMENSIONS			STAGE WEIGHTS	
	DIAMETER	LENGTH	DRY	AT LAUNCH
S-IC Base (including fins)	63.0 FEET	138 FEET	288,800 POUNDS	5,030,500 POUNDS
S-IC Mid-stage	33.0 FEET			
S-II Stage	33.0 FEET	81.5 FEET	92,600 POUNDS	1,050,000 POUNDS
S-IVB Stage	21.7 FEET	59.3 FEET	33,200 POUNDS	262,200 POUNDS
Instrument Unit	21.7 FEET	3.0 FEET	4,230 POUNDS	4,230 POUNDS

SATURN V STAGE MANUFACTURERS	
STAGE	MANUFACTURER
S-IC	THE BOEING COMPANY
S-II	NORTH AMERICAN-ROCKWELL
S-IVB	McDONNELL - DOUGLAS CORP.
S-IU	INTERNATIONAL BUSINESS MACHINE CORP.



PRE-LAUNCH LAUNCH VEHICLE GROSS WEIGHT ≈ 6,414,890 POUNDS

* MINIMUM VACUUM THRUST AT 120°F

† AT 170,000 FT. AND 70°F

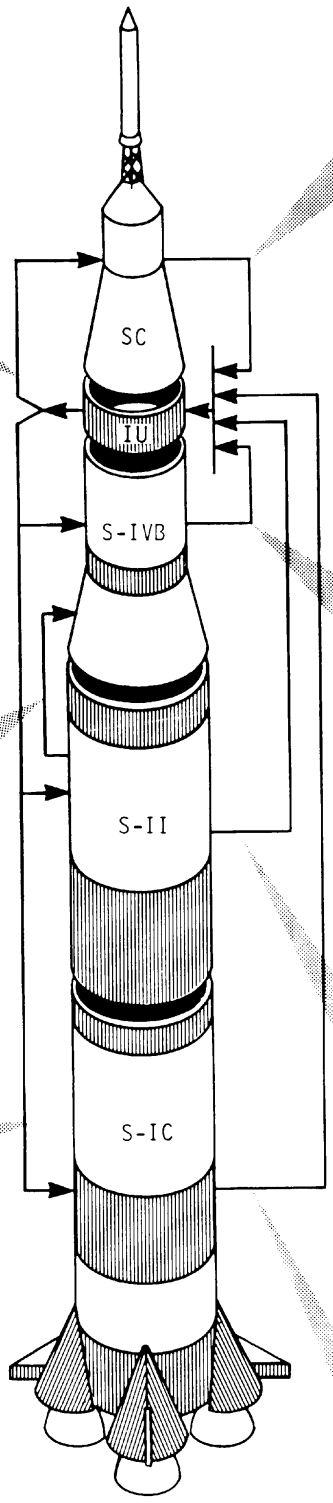
‡ NOMINAL VACUUM THRUST AT 60°F

** AT 175,000 FT AND 70°F

†† AT SEA LEVEL

NOTE: THRUST VALUES, WEIGHTS, AND BURN TIMES ARE ALL APPROXIMATIONS.

STAGE ELECTRICAL INTERFACE FLOW



IU TO SPACECRAFT

EDS LIFTOFF
EDS AUTO ABORT
+28 VDC FOR EDS
+28 VDC FOR Q BALL
S-IVB ULLAGE THRUST OK
GUIDANCE REFERENCE RELEASE
AGC LIFTOFF
Q BALL TEMPERATURE SENSING
S-II AND S-IVB FUEL TANK PRESSURE (V)
LV ATTITUDE REFERENCE FAILURE (V)
LV RATE EXCESSIVE (V)
EDS ABORT REQUEST (V)
S-II START/SEPARATION (V)
STAGE ENGINES OUT (V)

(V) = VISUALLY DISPLAYED

S-II TO S-IVB

+28 VDC FOR RETRO-ROCKET PRESSURE TRANSDUCER
S-IVB ENGINE START ENABLE

IU TO STAGES

STAGE ENGINE ACTUATOR COMMANDS
STAGE ENGINE ACTUATOR MEASURING VOLTAGES
+28 VDC FOR SWITCHING AND TIMING
STAGE SWITCH SELECTOR SIGNALS (VERIFY, COMMAND, ADDRESS, READ, RESET, ENABLE)
STAGE EDS COMMAND ENGINES OFF
S-IVB ATTITUDE CONTROL SYSTEM COMMANDS
TELEMETRY CLOCK AND SYNC.

SPACECRAFT TO IU

+28 VDC TO EDS
LV ENGINES CUTOFF TO EDS
ATTITUDE ERROR SIGNAL
Q-BALL PITCH AND YAW
S-IVB ENGINE CUTOFF
AGC COMMAND POWER
S-IVB IGNITION SEQUENCE START
AUTO ABORT DEACTIVATE (M)
INITIATE S-II/S-IVB SEPARATION (M)
SPACECRAFT CONTROL DISCRETE (M)
TRANSLUNAR INJECTION INHIBIT (M)

(M) = MANUALLY INITIATED

S-IVB TO IU

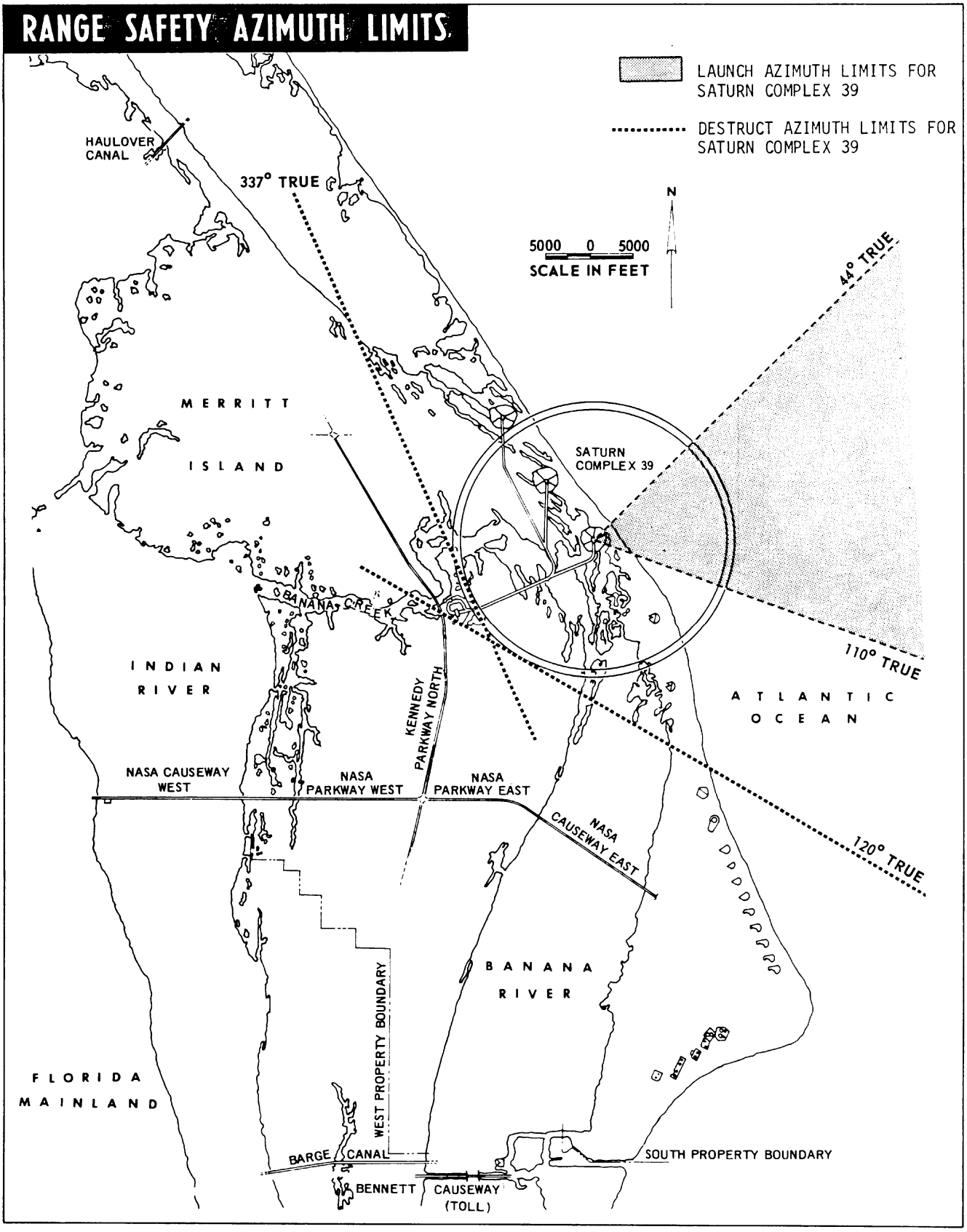
+28 VDC FOR TIMING
SWITCH SELECTOR ADDRESS VERIFICATION
ENGINE ACTUATOR POSITIONS
ATTITUDE CONTROL RATE GYROS SIGNALS
ATTITUDE CONTROL ACCELEROMETER SIGNALS
LOX TANK PRESSURE
FUEL TANK PRESSURE
RSCR & PD EBW FIRING UNIT ARM AND ENGINE CUTOFF ON
ENGINE THRUST OK
TELEMETRY SIGNALS

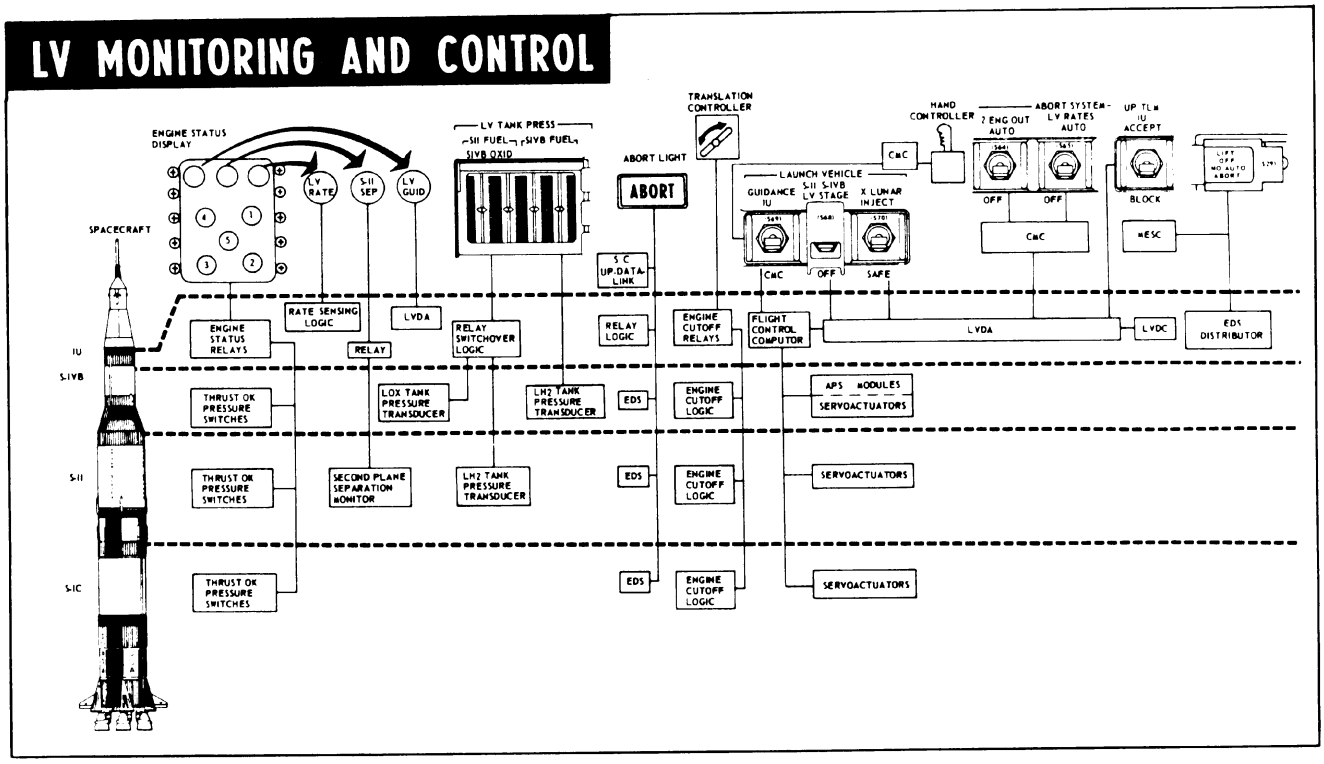
S-II TO IU

ENGINE ACTUATOR POSITIONS
+28VDC FOR TIMING
S-IC STAGE SEPARATED
AFT INTERSTAGE SEPARATED
S-II STAGE SEPARATED
S-II ENGINE OUT
S-II PROPELLANT DEPLETION
SWITCH SELECTOR VERIFY
FUEL TANK PRESSURE
ENGINE THRUST OK
LOX TANK PRESSURE

S-IC TO IU

ATTITUDE CONTROL ACCELEROMETER SIGNALS
ATTITUDE CONTROL RATE GYRO SIGNALS
+28 VDC FOR TIMING
ENGINES OUT
OUTBOARD ENGINE CUTOFF
S-II ENGINES START ENABLE
SWITCH SELECTOR ADDRESS VERIFY
S-IC THRUST OK

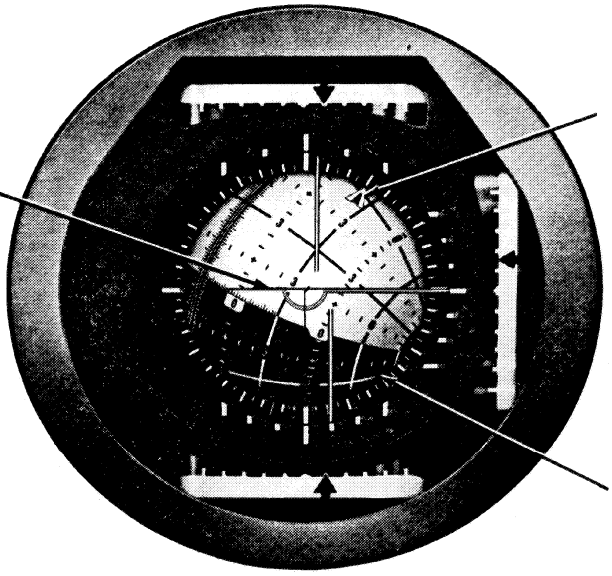

RANGE SAFETY AZIMUTH LIMITS
LAUNCH AZIMUTH LIMITS FOR SATURN COMPLEX 39
DESTRUCT AZIMUTH LIMITS FOR SATURN COMPLEX 39
HAULOVER CANAL
337° TRUE
N
5000 0 5000
SCALE IN FEET
44° TRUE
MERRITT ISLAND
SATURN COMPLEX 39
BANANA CREEK
INDIAN RIVER
KENNEDY PARKWAY NORTH
110° TRUE
ATLANTIC OCEAN
NASA CAUSEWAY WEST
NASA PARKWAY WEST
NASA PARKWAY EAST
NASA CAUSEWAY EAST
120° TRUE
BANANA RIVER
WEST PROPERTY BOUNDARY
FLORIDA MAINLAND
BARGE CANAL
SOUTH PROPERTY BOUNDARY
BENNETT CAUSEWAY (TOLL)


LV MONITORING AND CONTROL
ENGINE STATUS DISPLAY
LV RATE
S-II SEP
LV GUID
LV TANK PRESS
-SII FUEL-
-SIVB FUEL-
SIVB OXID
ABORT LIGHT
ABORT
TRANSLATION CONTROLLER
HAND CONTROLLER
2 ENG OUT AUTO
ABORT SYSTEM - LV RATES AUTO
UP TLM IU ACCEPT
LAUNCH VEHICLE
GUIDANCE IU
SII S-IVB LV STAGE
X LUNAR INJECT
CmC
OFF
SAFE
BLOCK
mESC
SPACECRAFT
IU
S-IVB
S-II
S-IC
S/C UP DATA LINK
ENGINE STATUS RELAYS
RATE SENSING LOGIC
LVDA
RELAY
RELAY SWITCHOVER LOGIC
RELAY LOGIC
ENGINE CUTOFF RELAYS
FLIGHT CONTROL COMPUTOR
LVDC
EDS DISTRIBUTOR
THRUST OK PRESSURE SWITCHES
LOX TANK PRESSURE TRANSDUCER
LH2 TANK PRESSURE TRANSDUCER
EDS
ENGINE CUTOFF LOGIC
APS MODULES
SERVOACTUATORS
SECOND PLANE SEPARATION MONITOR

TYPICAL CRITICAL EVENT SEQUENCE, FIRST OPPORTUNITY TLI
(EVENT TIMES FROM LIFTOFF INTO EARTH ORBIT ARE BASED ON AS-505 SIMULATIONS,
EVENT TIMES SUBSEQUENT TO T6 ARE ESTIMATED)

TIME FROM FIRST MOTION (HR:MIN:SEC)	TIME FROM REFERENCE (HR:MIN:SEC)	EVENT
-0:00:17.3	T_1-0:00:17.6	Guidance Reference Release
0:00:00.0	T_1-0:00:00.4	First Motion
0:00:00.4	T_1+0:00:00.0	Liftoff
0:00:01.4	T_1+0:00:01.0	Begin Tower Clearance Yaw Maneuver
0:00:09.4	T_1+0:00:09.0	End Yaw Maneuver
0:00:12.3	T_1+0:00:11.9	Pitch and Roll Initiation
0:00:31.3	T_1+0:00:30.9	End Roll Maneuver
0:01:05.6	T_1+0:01:05.2	Mach 1
0:01:20.9	T_1+0:01:20.5	Maximum Dynamic Pressure
0:02:15:0	T_2+0:00:00.0	S-IC Center Engine Cutoff
0:02:37.5	T_2+0:00:22.5	Begin Tilt Arrest
0:02:40.4	T_3+0:00:00.0	S-IC Outboard Engine Cutoff
0:02:40.9	T_3+0:00:00.5	S-II Ullage Rocket Ignition
0:02:41.1	T_3+0:00:00.7	Signal to Separation Devices and S-IC Retrorockets
0:02:41.2	T_3+0:00:00.8	S-IC/S-II First Plane Separation Complete
0:02:41.8	T_3+0:00:01.4	S-II Engine Start Sequence Initiated
0:02:42.8	T_3+0:00:02.4	S-II Ignition (Start Tank Discharge Valve Opens)
0:02:44.8	T_3+0:00:04.4	S-II Engines at 90% Thrust
0:02:45.4	T_3+0:00:05.0	S-II Ullage Thrust Cutoff
0:03:10.9	T_3+0:00:30.5	S-II Aft Interstage Drop (Second Plane Separation)
0:03:16.6	T_3+0:00:36.2	LET Jettison (Crew Action)
0:03:21.3	T_3+0:00:40.9	Initiate IGM
0:07:41.8	T_3+0:05:01.4	S-II Fuel Tank Pressurization Flowrate Step
0:08:49.2	T_4+0:00:00.0	S-II Engine Cutoff
0:08:49.9	T_4+0:00:00.7	S-IVB Ullage Ignition
0:08:50.0	T_4+0:00:00.8	Signal to Separation Devices and S-II Retrorockets
0:08:50.1	T_4+0:00:00.9	S-II/S-IVB Separation
0:08:50.2	T_4+0:00:01.0	S-IVB Engine Start Sequence, First Burn
0:08:53.2	T_4+0:00:04.0	S-IVB Ignition (Start Tank Discharge Valve Opens)
0:08:55.7	T_4+0:00:06.5	S-IVB Engine at 90% Thrust
0:08:57.8	T_4+0:00:08.6	S-IVB Ullage Thrust End
0:09:02.1	T_4+0:00:12.9	S-IVB Ullage Case Jettison
0:11:06.5	T_4+0:02:17.3	Begin Chi Freeze
0:11:14.2	T_5+0:00:00.0	S-IVB Cutoff, First Burn
0:11:14.5	T_5+0:00:00.3	S-IVB APS Ullage Engines On
0:11:24.0	T_5+0:00:09.8	Parking Orbit Insertion
0:11:34.5	T_5+0:00:20.3	Begin Orbital Guidance
0:12:13.2	T_5+0:00:59.0	LH_2 Continuous Vent Open
0:12:42.2	T_5+0:01:28.0	Ullage Engines Cutoff
0:13:02.5	T_5+0:01:48.3	Begin Orbital Navigation Calculations
2:22:10.0	T_6+0:00:00.0	Begin S-IVB Restart Preparations
2:22:51.3	T_6+0:00:41.3	O_2H_2 Burner (Helium Heater) On
2:22:52.2	T_6+0:00:42.2	LH_2 Continuous Vent Closed
2:30:26.3	T_6+0:08:16.3	Ullage Engines On
2:30:31.3	T_6+0:08:21.3	Helium Heater Off
2:31:40.0	T_6+0:09:30.0	S-IVB Engine Restart Sequence
2:31:43.0	T_6+0:09:33.0	Ullage Engines Cutoff
2:31:48.0	T_6+0:09:38.0	S-IVB Ignition, Second Burn (Start Tank Discharge Valve Opens)
2:31:50.5	T_6+0:09:40.5	S-IVB at 90% Thrust
2:37:22.0	T_7+0:00:00.0	S-IVB Engine Cutoff, Second Burn
2:37:22.3	T_7+0:00:00.3	LH_2 Continuous and Nonpropulsive Vents Open
2:37:22.6	T_7+0:00:00.6	Lox Nonpropulsive Vent Open
2:37:22.8	T_7+0:00:00.8	Engine Start Bottle Dump On
2:37:23.0	T_7+0:00:01.0	Cold Helium Bottle Dump On
2:37:31.8	T_7+0:00:09.8	Translunar Injection
2:37:42.0	T_7+0:00:20.0	Begin Orbital Guidance
2:39:02.0	T_7+0:01:40.0	Begin Orbital Navigation
2:39:52.6	T_7+0:02:30.6	Lox Nonpropulsive Vent Closed
2:39:54.8	T_7+0:02:32.8	Engine Start Bottle Dump Off
2:52:22.3	T_7+0:15:00.3	LH_2 Continuous and Nonpropulsive Vents Closed
2:52:23.0	T_7+0:15:01.0	Cold Helium Bottle Dump Off
2:53:22.0	T_7+0:16:00.0	Maneuver Space Vehicle to CSM Separation Attitude
3:05:22.0	T_7+0:28:00.0	CSM Separation
3:18:22.0	T_7+0:41:00.0	CSM Docking
3:37:22.0	T_7+1:00:00.0	LH_2 Nonpropulsive Vent Open
3:37:22.3	T_7+1:00:00.3	Cold Helium Bottle Dump On
4:00:42.0	T_7+1:23:20.0	LH_2 Nonpropulsive Vent Closed
4:00:42.3	T_7+1:23:20.3	Cold Helium Bottle Dump Off
4:05:22.0	T_7+1:28:00.0	CSM/LM Separation from LV
4:37:22.0	T_8+0:00:00.0	Commence S-IVB Translunar Safing
4:37:22.3	T_8+0:00:00.3	LH_2 Continuous Vent Latched Open
4:37:22.6	T_8+0:00:00.6	S-IVB Pneumatic Bottle Dump On
4:37:22.9	T_8+0:00:00.9	Cold Helium Bottle Dump On
4:49:22.0	T_8+0:12:00.0	Lox Dump On
4:49:22.3	T_8+0:12:00.3	Engine Control Bottle and Ambient Repressurization Bottle Dump On
4:54:22.0	T_8+0:17:00.0	Lox Dump Off
4:54:25.0	T_8+0:17:03:0	Lox Nonpropulsive Vent Latched Open
4:54:31.0	T_8+0:17:09.0	LH_2 Dump On
5:07:22.0	T_8+0:30:00.0	Cold Helium Bottle Dump Off
5:11:11.0	T_8+0:33:49.0	LH_2 Dump Off
5:11:13.0	T_8+0:33:51.0	LH_2 Nonpropulsive Vent Latched Open
5:16:12.3	T_8+0:38:50.3	Engine Control Bottle and Ambient Repressurization Bottle Dump Off
5:24:12.0	T_8+0:46:40.0	Ullage Engines On
5:37:22.6	T_8+1:00:00.6	S-IVB Pneumatic Bottle Dump Off
5:39:12.0	T_8+1:01:40.0	Ullage Engines Cutoff

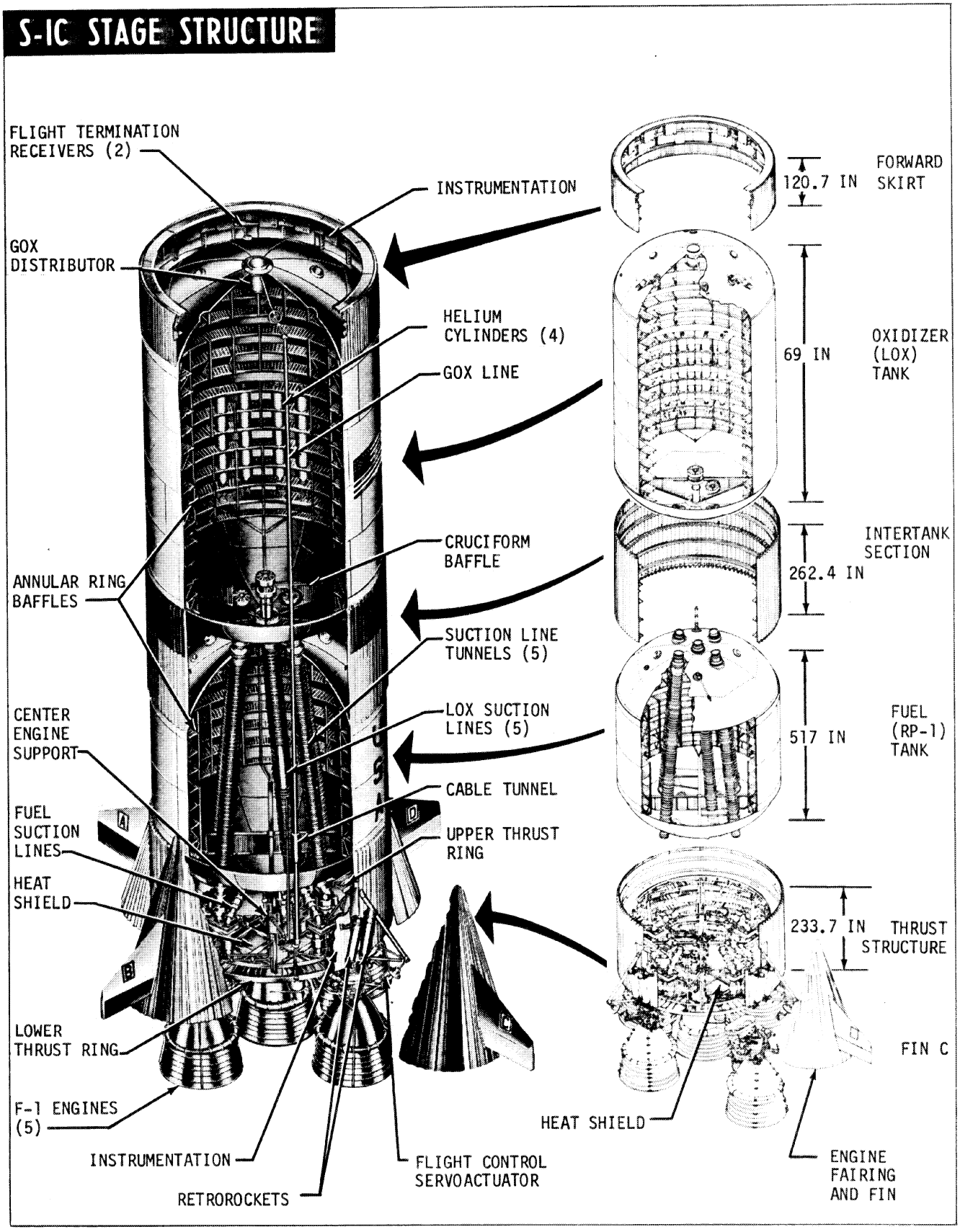
FLIGHT DIRECTOR ATTITUDE INDICATOR



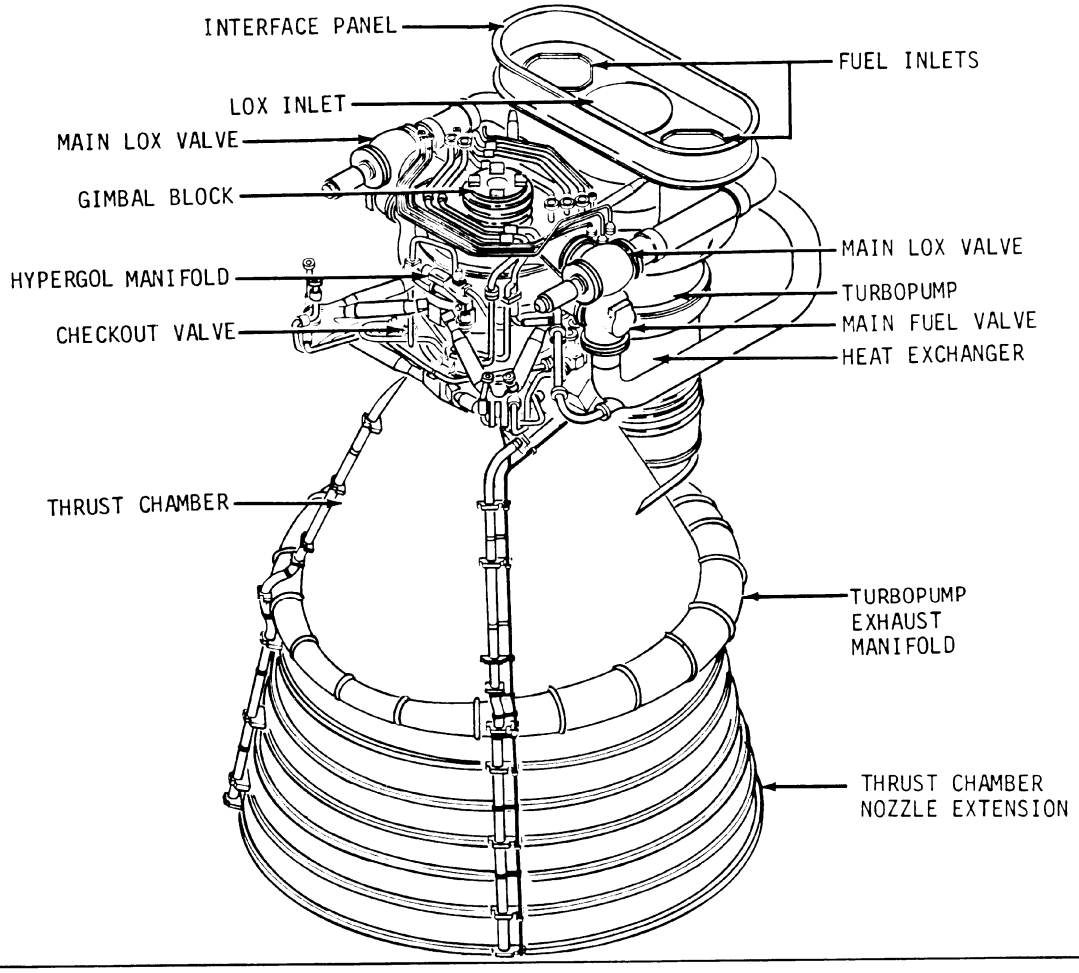
EULER ATTITUDE ON BALL
PITCH - θ = 014°
YAW - ψ = 034°
ROLL - ϕ = 330°

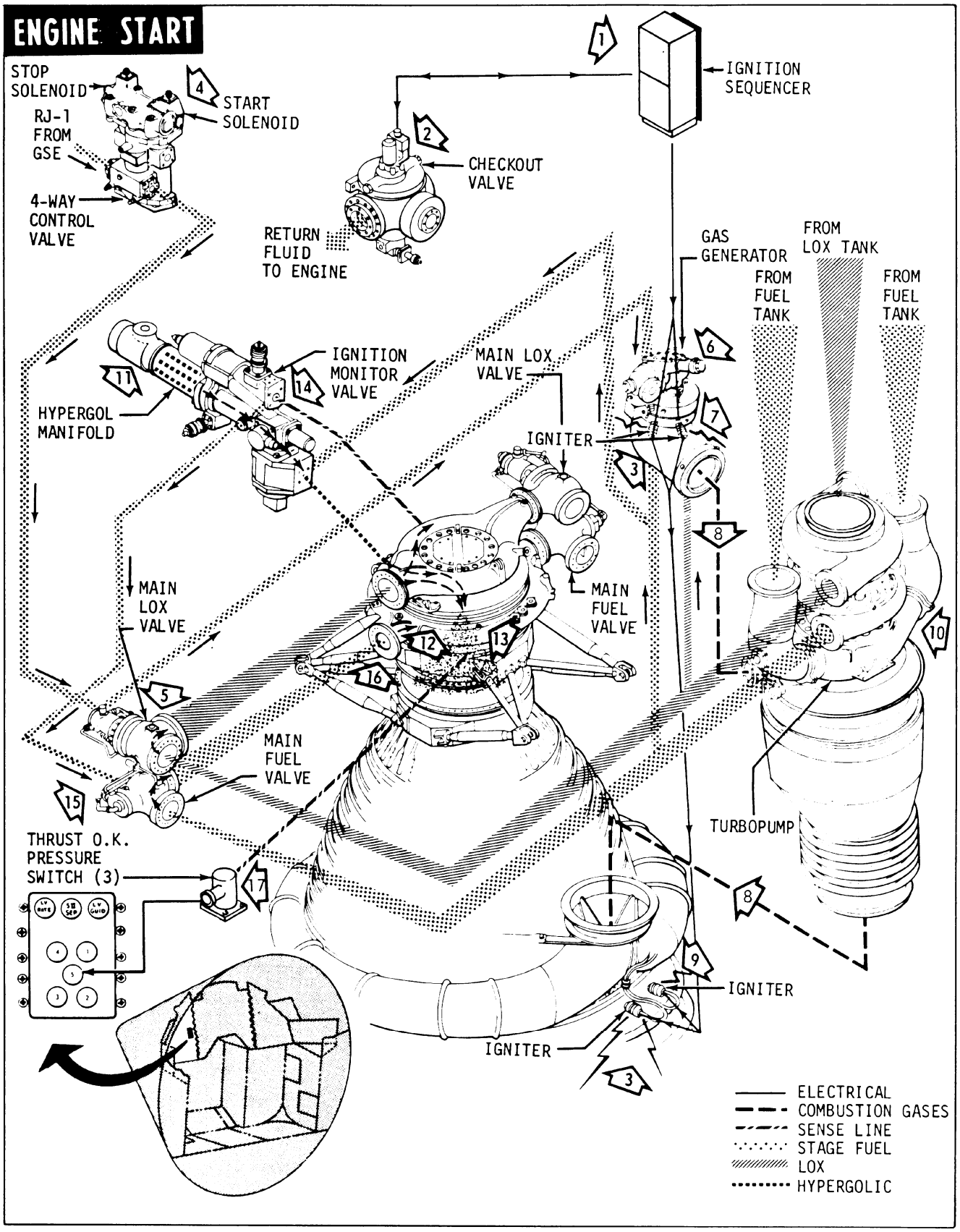
NOTE:
ALL POLARITIES INDICATE VEHICLE DYNAMICS

NOMINAL LAUNCH PHASE VOICE CALLOUTS (BOOST ONLY)			
TIME	STATION	REPORT	EVENT
-0:09	LCC	IGNITION	S-IC IGNITION
0:00	LCC	LIFTOFF	UMBILICAL DISCONNECT
0:01	CDR	LIFTOFF	CMD TO P11 DET START
0:12	CDR	ROLL COMMENCE	ROLL PROGRAM STARTS
0:21	CDR	PITCH TRACKING	PITCH RATE DETECTION
0:31	CDR	ROLL COMPLETE	ROLL COMPLETE
0:42	MCC	MARK, MODE IB	PRPLNT DUMP - RCS CMD
1:50	MCC	MARK, MODE IC	h = 100,000 FT, 16.5 NM
2:00	CDR	EDS MANUAL	EDS RATES - OFF EDS ENG - OFF EDS AOA - Pc
2:00	MCC	GO/NO GO FOR STAGING	STAGING STATUS-TWR JETT STATUS IF REQUIRED
2:00	CDR	GO/NO GO FOR STAGING	
2:14	CDR	INBOARD OFF	S-IC INBOARD ENG - OFF
2:39	CDR	OUTBOARD OFF	S-IC OUTBOARD ENG - OFF
2:40	CDR	STAGING	S-II LIGHTS OFF
2:41			S-II IGNITION COMMAND
2:44	CDR	S-II 65%	S-II 65%
3:10	CDR	S-II SEP LIGHT OUT	S-II SEP LIGHT OUT
3:16	CDR	TOWER JETT MARK, MODE II	TOWER JETTISONED MAN ATT (P) - RATE CMD
3:21	CDR	GUID INITIATE	IGM STARTS
4:00	CDR	S/C GO/NO GO	
	MCC	GUIDANCE GO/NO GO	IGM LOOKS GOOD
4:30	MCC	TRAJECTORY GO/NO GO	TRAJECTORY STATUS
5:00	CDR	S/C GO/NO GO	
*5:50	MCC	S-IVB TO ORBIT CAPABILITY	
6:00	CDR	S/C GO/NO GO	
7:00	CDR	S/C GO/NO GO	
8:00	CDR	S/C GO/NO GO	
8:33	MCC	GO/NO GO FOR STAGING	STAGING STATUS
8:53	CDR	S-II OFF	S-II LIGHTS - ON
8:54	CDR	STAGING	S-IVB LIGHT - OFF
8:55	CDR	S-IVB IGNITION	S-IVB IGNITION
9:00	CDR	S-IVB 65%	S-IVB 65%
10:00	MCC	MODE IV	
10:05	MCC CDR	S/C GO/NO GO FOR ORBIT	
10:49	CDR	SECO	S-IVB LIGHT ON
10:59	MCC	INSERTION	
*LAUNCH VEHICLE CAPABILITY			


S-IC STAGE STRUCTURE
FLIGHT TERMINATION RECEIVERS (2)
INSTRUMENTATION
GOX DISTRIBUTOR
HELIUM CYLINDERS (4)
GOX LINE
CRUCIFORM BAFFLE
ANNULAR RING BAFFLES
SUCTION LINE TUNNELS (5)
CENTER ENGINE SUPPORT
LOX SUCTION LINES (5)
CABLE TUNNEL
FUEL SUCTION LINES
UPPER THRUST RING
HEAT SHIELD
LOWER THRUST RING
F-1 ENGINES (5)
INSTRUMENTATION
RETROROCKETS
FLIGHT CONTROL SERVOACTUATOR
120.7 IN
FORWARD SKIRT
69 IN
OXIDIZER (LOX) TANK
INTERTANK SECTION
262.4 IN
517 IN
FUEL (RP-1) TANK
233.7 IN
THRUST STRUCTURE
FIN C
HEAT SHIELD
ENGINE FAIRING AND FIN

F-1 ENGINE MAJOR COMPONENTS




ENGINE START
STOP SOLENOID
START SOLENOID
RJ-1 FROM GSE
4-WAY CONTROL VALVE
IGNITION SEQUENCER
CHECKOUT VALVE
RETURN FLUID TO ENGINE
GAS GENERATOR
FROM LOX TANK
FROM FUEL TANK
FROM FUEL TANK
IGNITION MONITOR VALVE
MAIN LOX VALVE
HYPERGOL MANIFOLD
IGNITER
MAIN LOX VALVE
MAIN FUEL VALVE
MAIN FUEL VALVE
TURBOPUMP
THRUST O.K. PRESSURE SWITCH (3)
IGNITER
IGNITER
ELECTRICAL
COMBUSTION GASES
SENSE LINE
STAGE FUEL
LOX
HYPERGOLIC

ENGINE START

1. Engine start is part of the terminal countdown sequence. When this point in the countdown is reached, the ignition sequencer controls starting of all five engines.

2. Checkout valve moves to engine return position.

3. Electrical signal fires igniters (4 each engine).

   a) Gas generator combustor and turbine exhaust igniters burn igniter links to trigger electrical signal to start solenoid of 4-way control valve.

   b) Igniters burn approximately six seconds.

4. Start solenoid of 4-way control valve directs GSE hydraulic pressure to main lox valves.

5. Main lox valves allow lox to flow to thrust chamber and GSE hydraulic pressure to flow through sequence valve to open gas generator ball valve.

6. Propellants, under tank pressure, flow into gas generator combustor.

7. Propellants are ignited by flame of igniters.

8. Combustion gas passes through turbopump, heat exchanger, exhaust manifold and nozzle extension.

9. Fuel rich turbine combustion gas is ignited by flame from igniters.

   a) Ignition of this gas prevents backfiring and burping.

   b) This relatively cool gas (approximately 1,000°F) is the coolant for the nozzle extension.

10. Combustion gas accelerates the turbopump, causing the pump discharge pressure to increase.

11. As fuel pressure increases to approximately 375 psig, it ruptures the hypergol cartridge.

12. The hypergolic fluid and fuel are forced into the thrust chamber where they mix with the lox to cause ignition.

TRANSITION TO MAINSTAGE

13. Ignition causes the combustion zone pressure to increase.

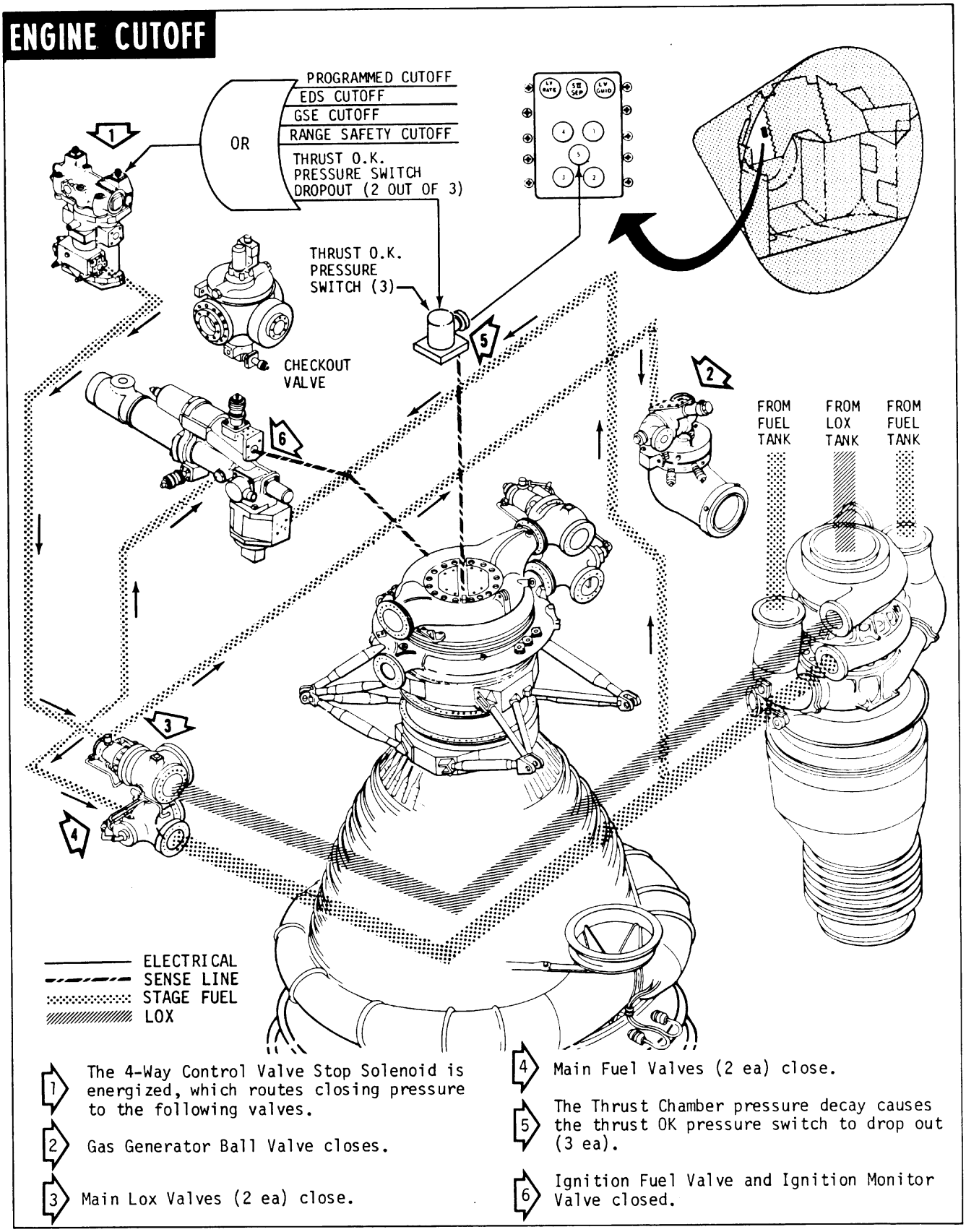
14. As pressure reaches 20 psig, the ignition monitor valve directs fluid pressure to the main fuel valves.

15. Fluid pressure opens main fuel valves.

16. Fuel enters thrust chamber. As pressure increases the transition to mainstage is accomplished.

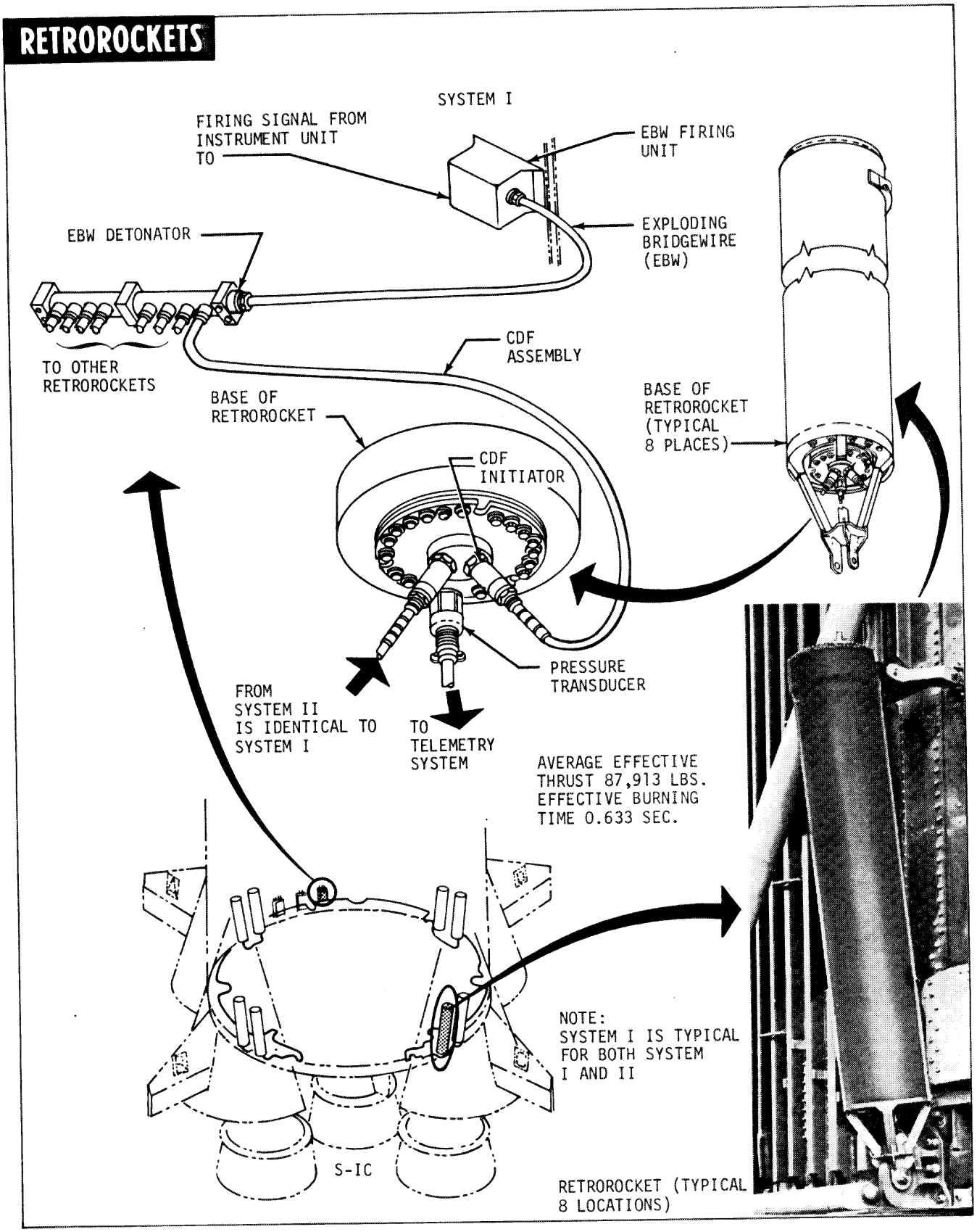
17. The thrust OK pressure switch (which senses fuel injection pressure) picks up at approximately 1060 psi and provides a THRUST OK signal to the IU.

ENGINE CUTOFF

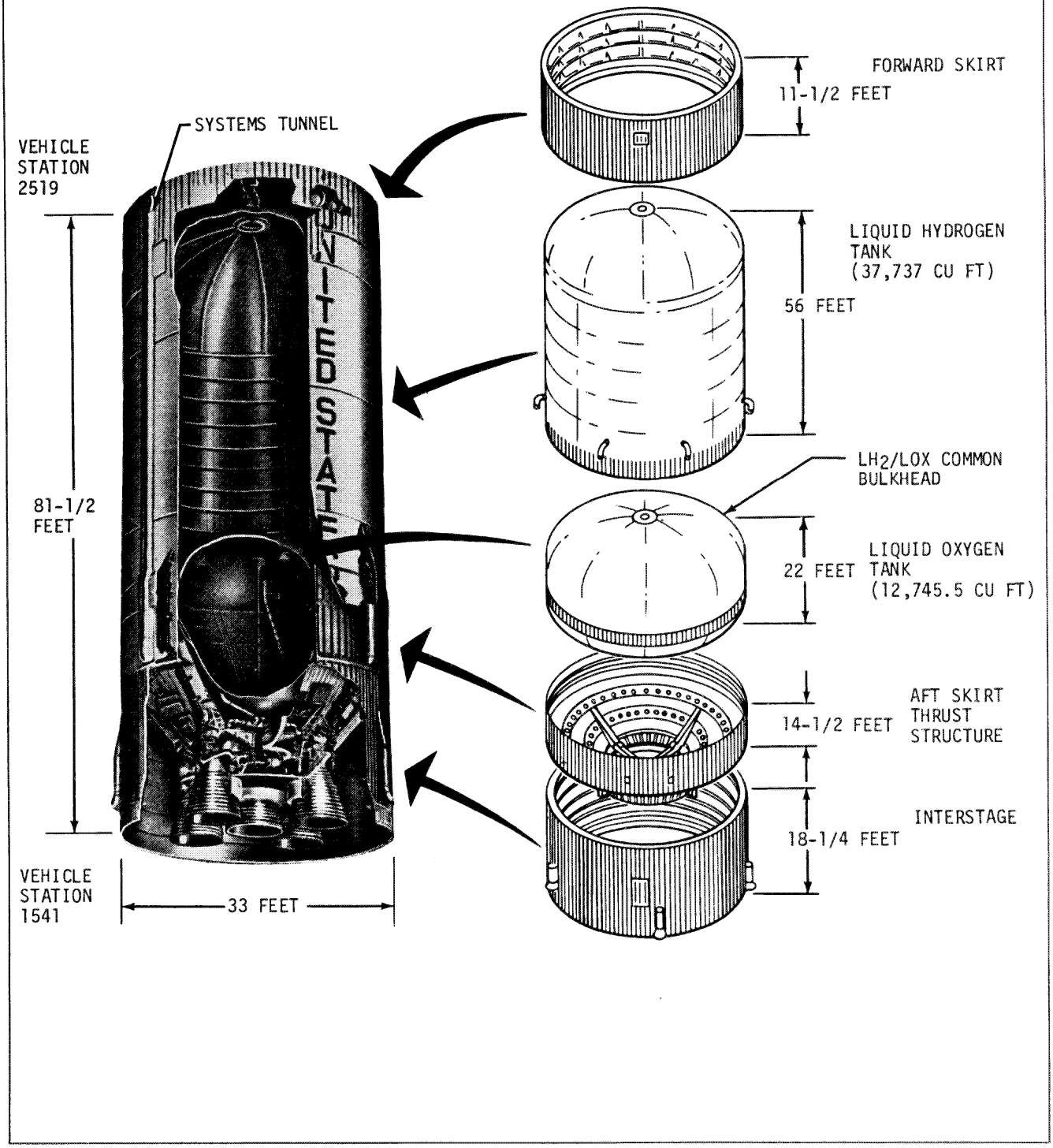


1. The 4-Way Control Valve Stop Solenoid is energized, which routes closing pressure to the following valves.
2. Gas Generator Ball Valve closes.
3. Main Lox Valves (2 ea) close.
4. Main Fuel Valves (2 ea) close.
5. The Thrust Chamber pressure decay causes the thrust OK pressure switch to drop out (3 ea).
6. Ignition Fuel Valve and Ignition Monitor Valve closed.

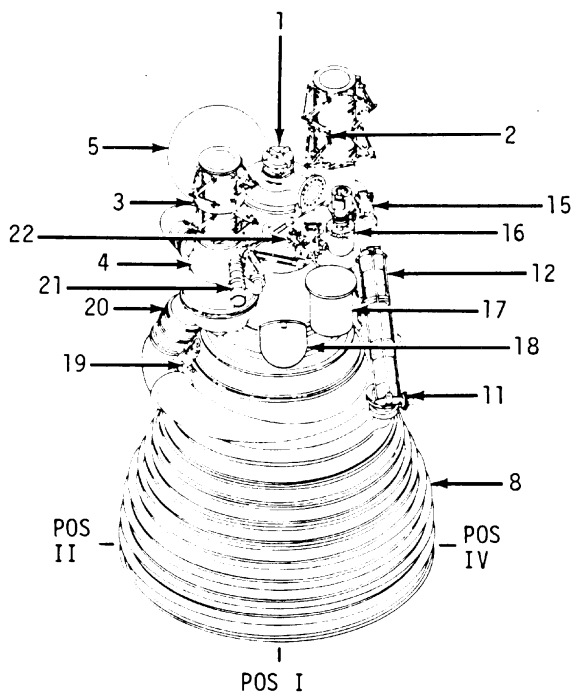
RETROROCKETS

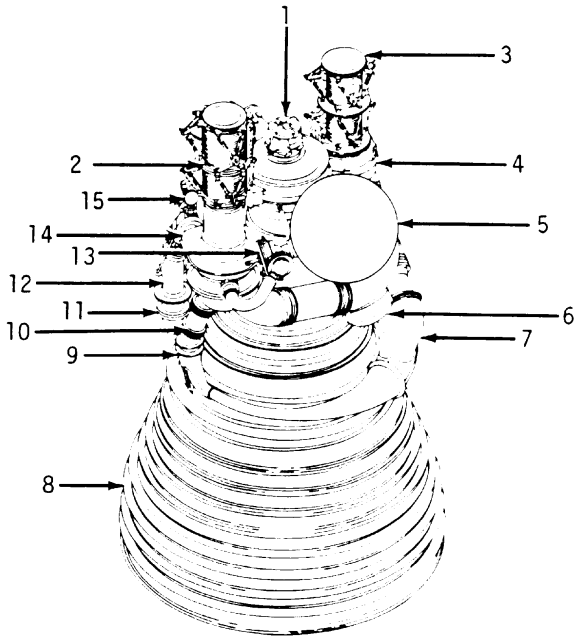


S-II STAGE STRUCTURE



J-2 ROCKET ENGINE

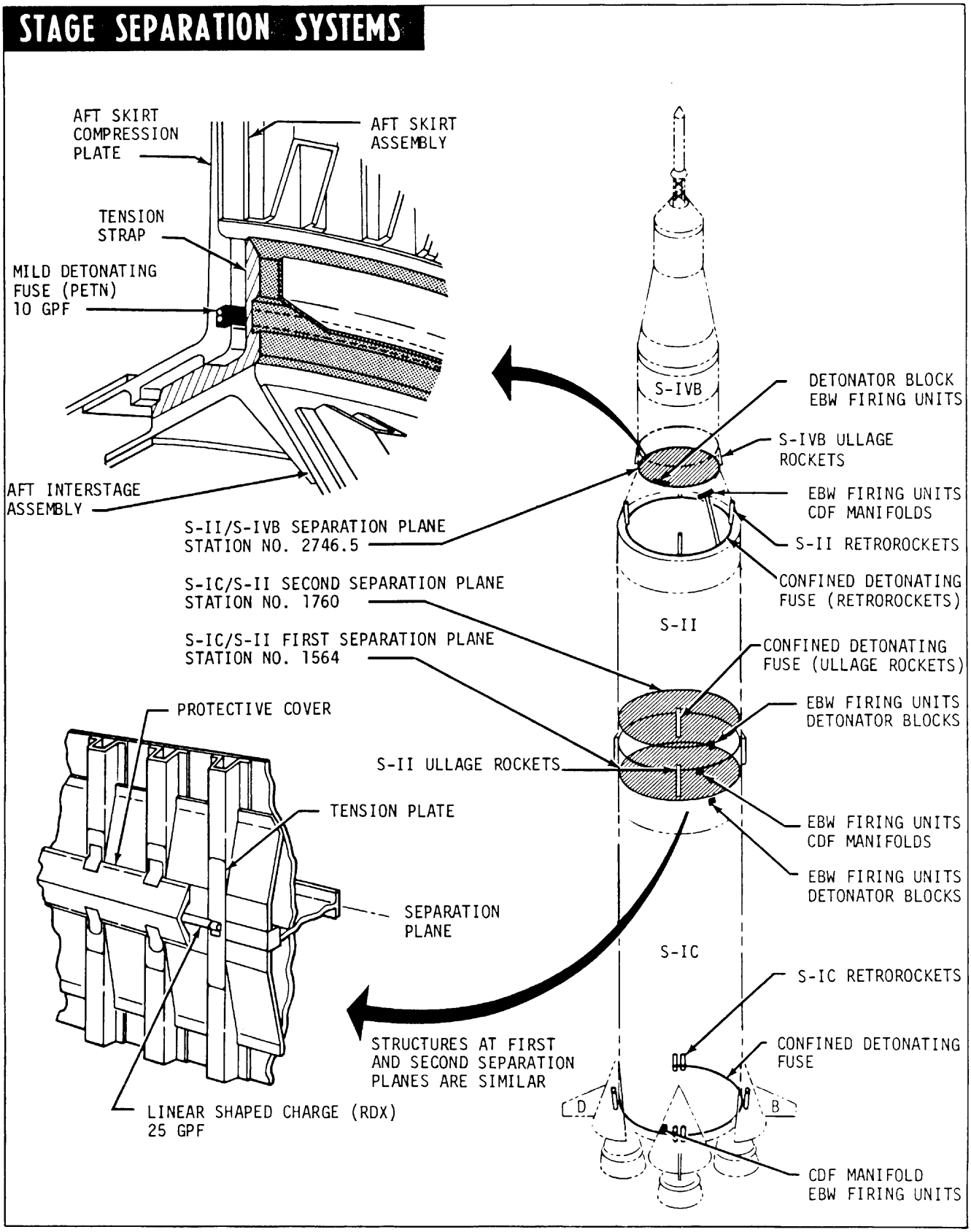




VIEW ROTATED 180°

1. GIMBAL
2. FUEL INLET DUCT
3. OXIDIZER INLET DUCT
4. OXIDIZER TURBOPUMP
5. START TANK
6. AUXILIARY FLIGHT INSTRUMENTATION PACKAGE
7. EXHAUST MANIFOLD
8. THRUST CHAMBER
9. OXIDIZER TURBINE BYPASS VALVE
10. TURBINE BYPASS DUCT
11. MAIN FUEL VALVE
12. HIGH PRESSURE FUEL DUCT
13. START TANK DISCHARGE VALVE
14. FUEL TURBOPUMP
15. FUEL BLEED VALVE
16. GAS GENERATOR
17. ELECTRICAL CONTROL PACKAGE
18. PRIMARY FLIGHT INSTR. PACKAGE
19. ANTI-FLOOD CHECK VALVE
20. HEAT EXCHANGER
21. PROPELLANT UTILIZATION VALVE
22. PNEUMATIC CONTROL PACKAGE

STAGE SEPARATION SYSTEMS



S-IC/S-II AND S-II/S-IVB SEPARATION

S-IC/S-II separation

1. EBW firing units enabled

A ground-latched interlock renders all the EBW firing units on the Saturn V inoperative while the vehicle is on the launch pad. The interlock is released with umbilical disconnect during liftoff, and the subsystem is reset to flight conditions.

2. S-IC/S-II separation ordnance arm

The ordnance-arm command is routed through the S-II switch selector to both the S-IC stage electrical circuitry to supply 28 vdc to the EBW units for first-plane separation and retrorocket ignition, and to the S-II stage electrical circuitry to supply 28 vdc to the EBW units for ullage rocket ignition and second-plane separation.

3. S-IC outboard engine cutoff followed by S-II ullage rocket ignition

4. First plane separation

Second plane separation is enabled by the removal of an electrical interlock during first plane separation.

5. Second plane separation

The second plane separation command is generated by the IU approximately thirty seconds after first plane separation. This delay permits the transient vehicle motion, associated with first plane separation, to dampen out.

The separation command is routed to the S-II switch selector to trigger the ordnance train and ignite the LSC for second plane separation. The LSC detonates, severing the S-II interstage from the S-II stage. The combined effect of vehicle acceleration and the reaction caused by the J-2 engine exhaust plume impingement retards the interstage .

S-II/S-IVB separation

Physical separation is initiated by the IU at the end of the S-II boost phase following shutdown of the five J-2 engines. Separation requires the performance of the following major functions in the sequence described:

6. S-II/S-IVB separation ordnance arm

The ordnance-arm command is routed through the S-II switch selector to both the S-II and S-IVB stage electrical circuitry and carries 28 vdc to the EBW firing units for S-II/S-IVB separation and retrorocket ignition.

7. S-II/S-IVB separation

Four solid propellant S-II retrockets. (figure 5-22) are mounted at equal intervals on the periphery of the S-II/S-IVB interstage structure and are used to retard the S-II stage after separation.

Figure 5-20 (Sheet 1 of 2)

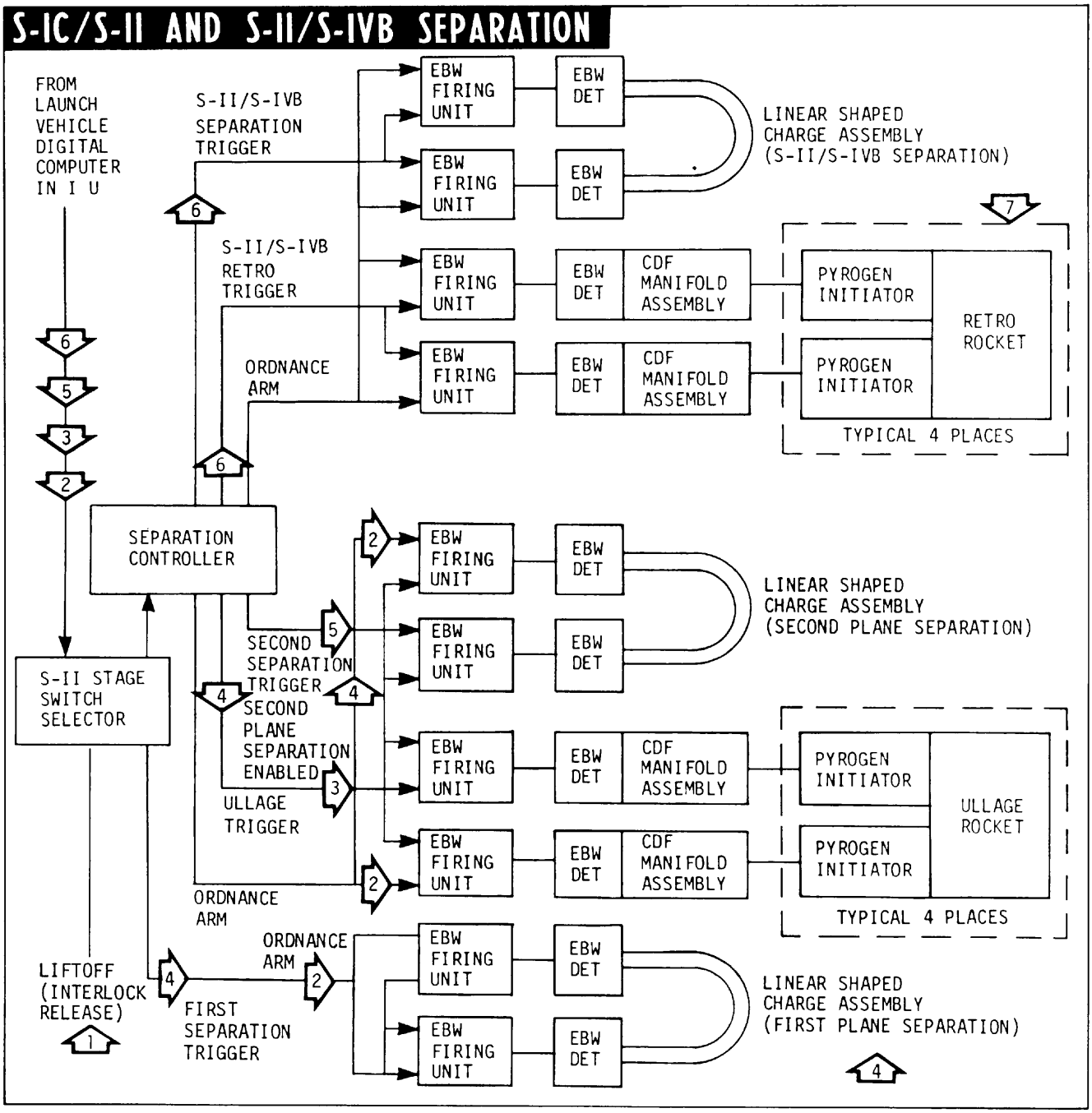
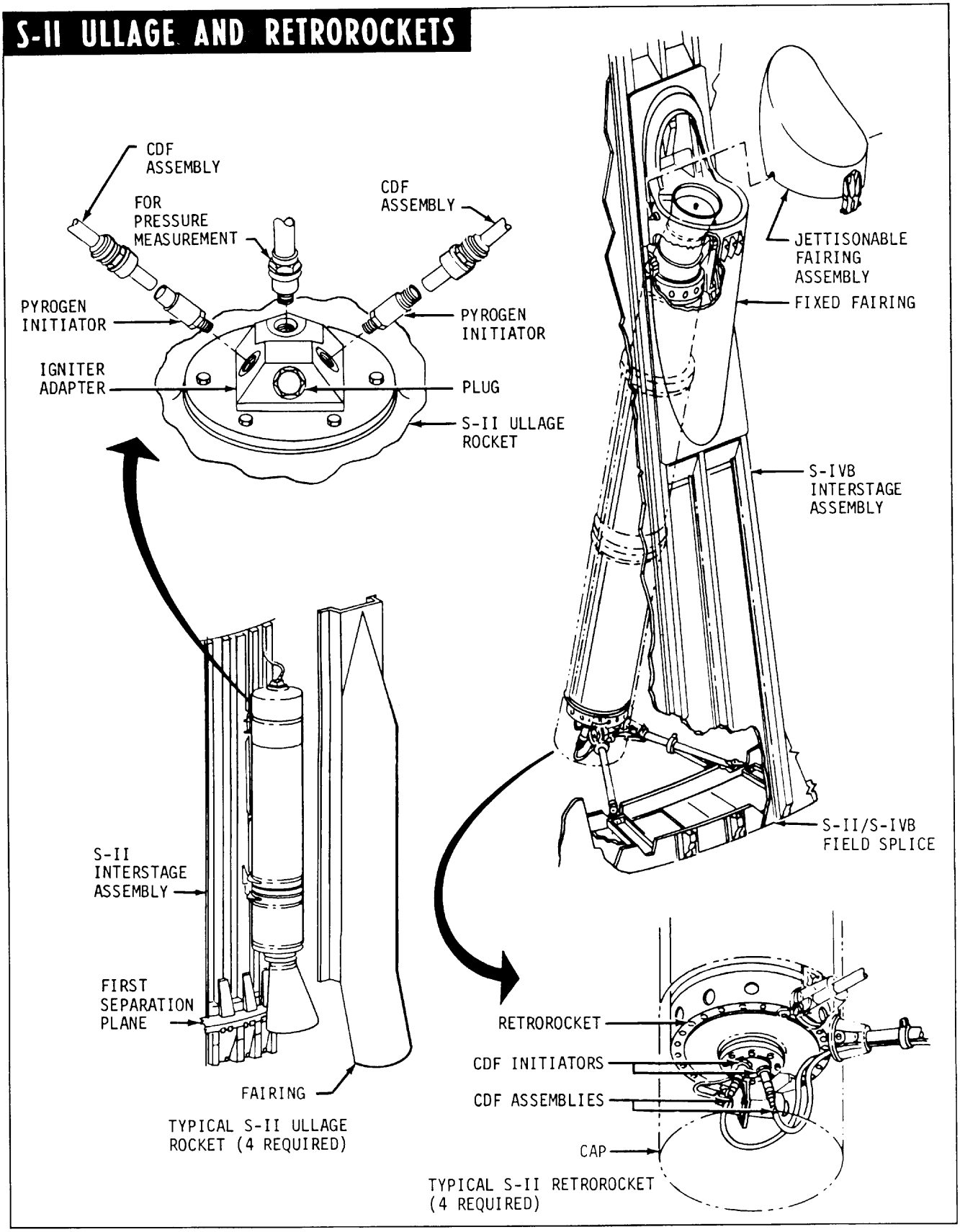
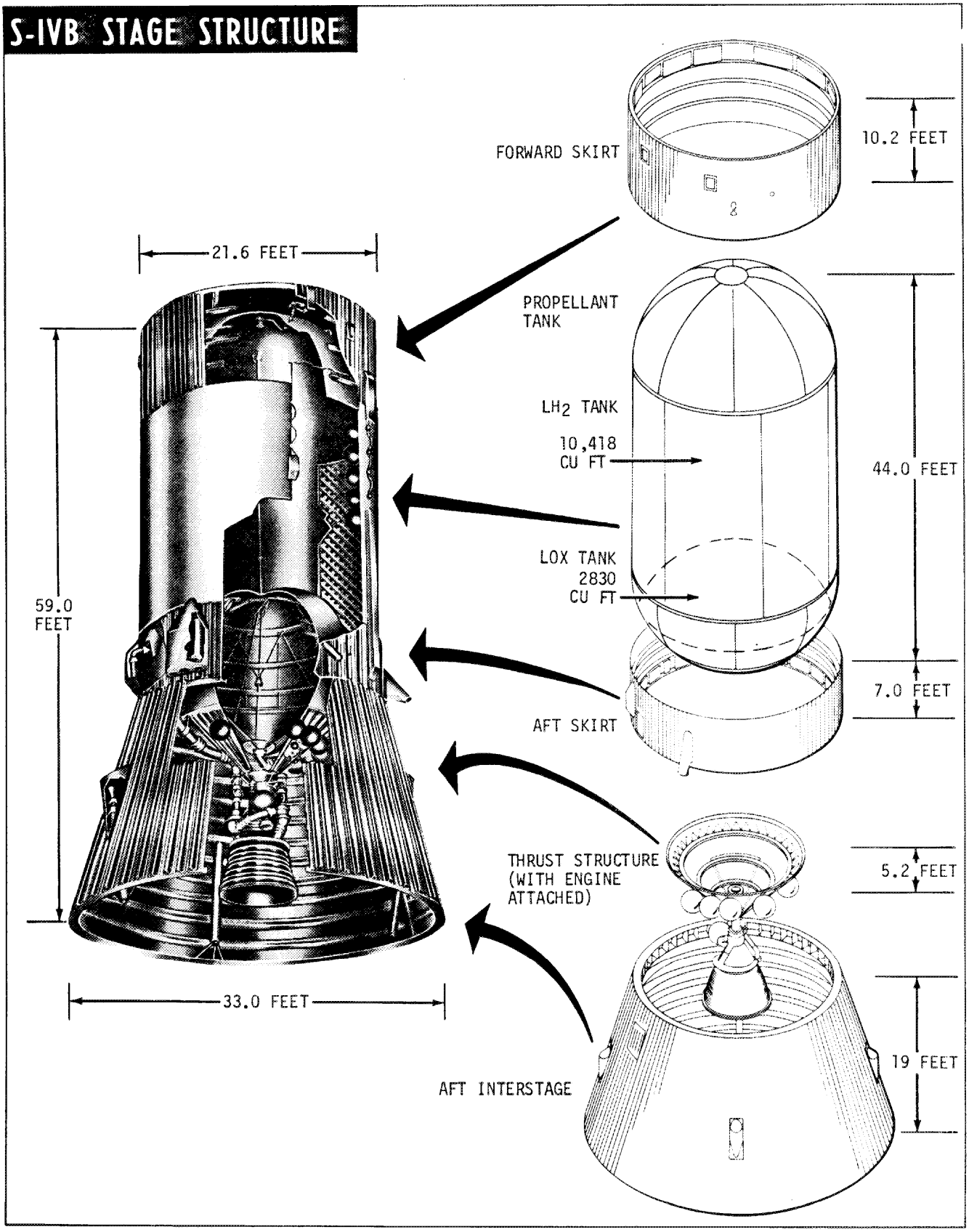
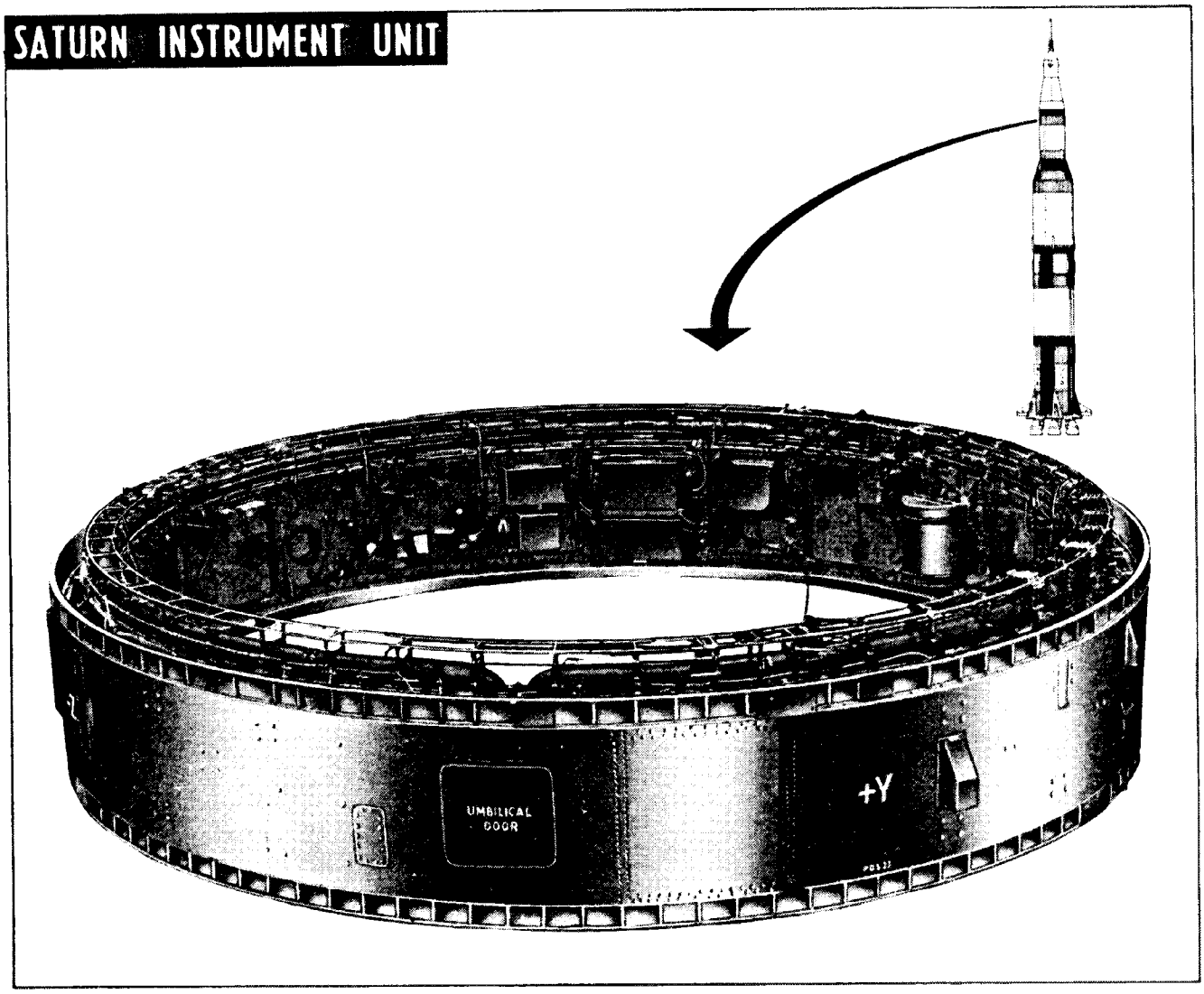


Figure 5-20 (Sheet 2 of 2)

S-II ULLAGE AND RETROROCKETS




S-IVB STAGE STRUCTURE
FORWARD SKIRT
10.2 FEET
21.6 FEET
PROPELLANT TANK
LH2 TANK
10,418 CU FT
LOX TANK
2830 CU FT
44.0 FEET
59.0 FEET
AFT SKIRT
7.0 FEET
THRUST STRUCTURE (WITH ENGINE ATTACHED)
5.2 FEET
AFT INTERSTAGE
19 FEET
33.0 FEET


SATURN INSTRUMENT UNIT
UMBILICAL DOOR
+Y

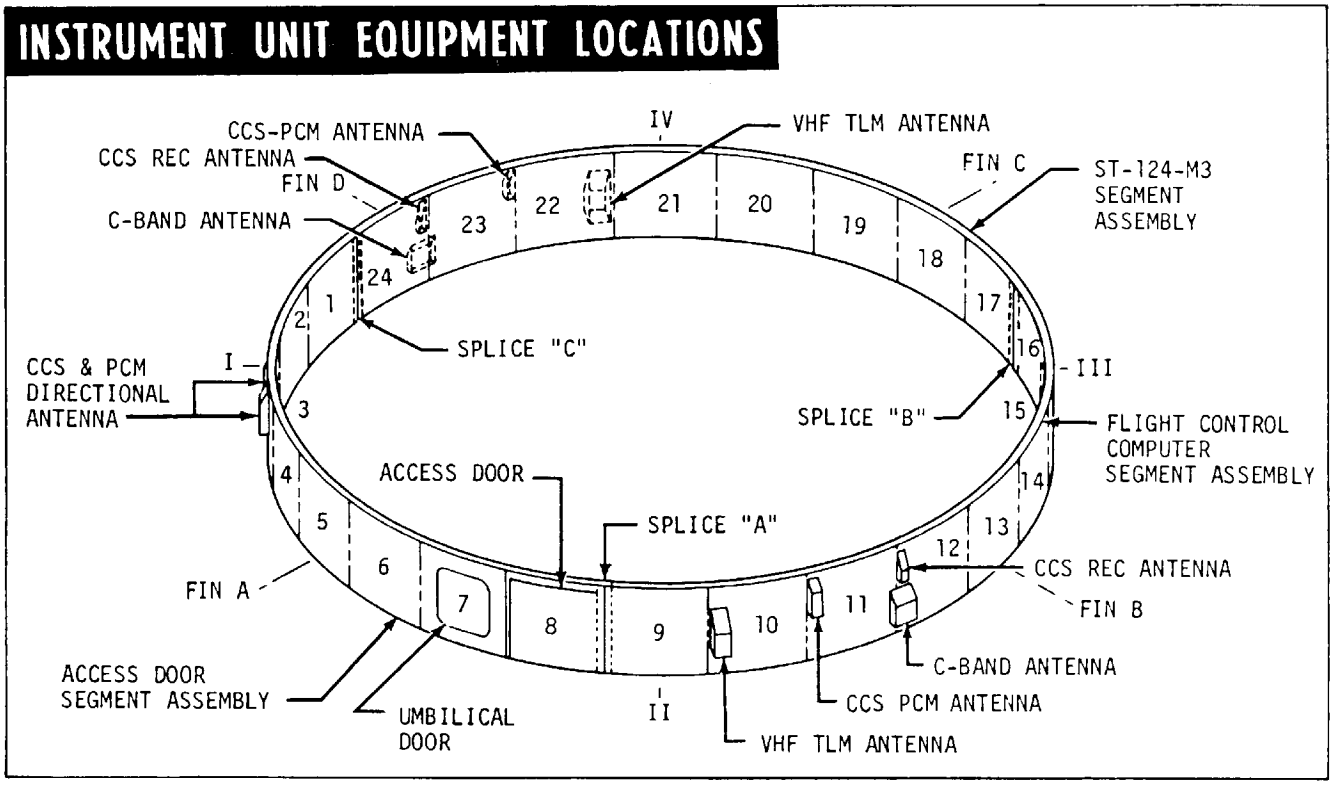


Figure 7-4 (Sheet 1 of 5)

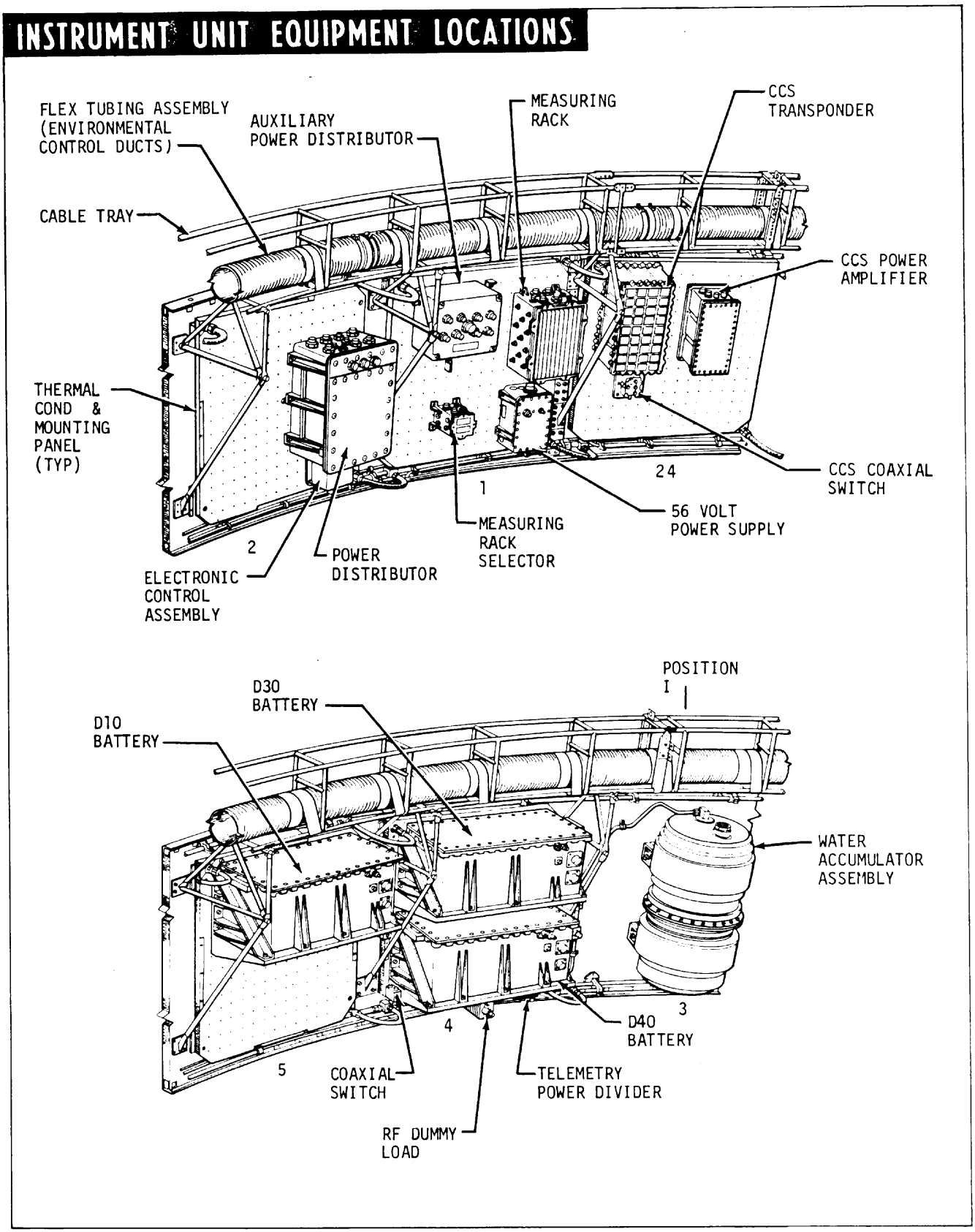


Figure 7-4 (Sheet 2 of 5)

INSTRUMENT UNIT EQUIPMENT LOCATIONS

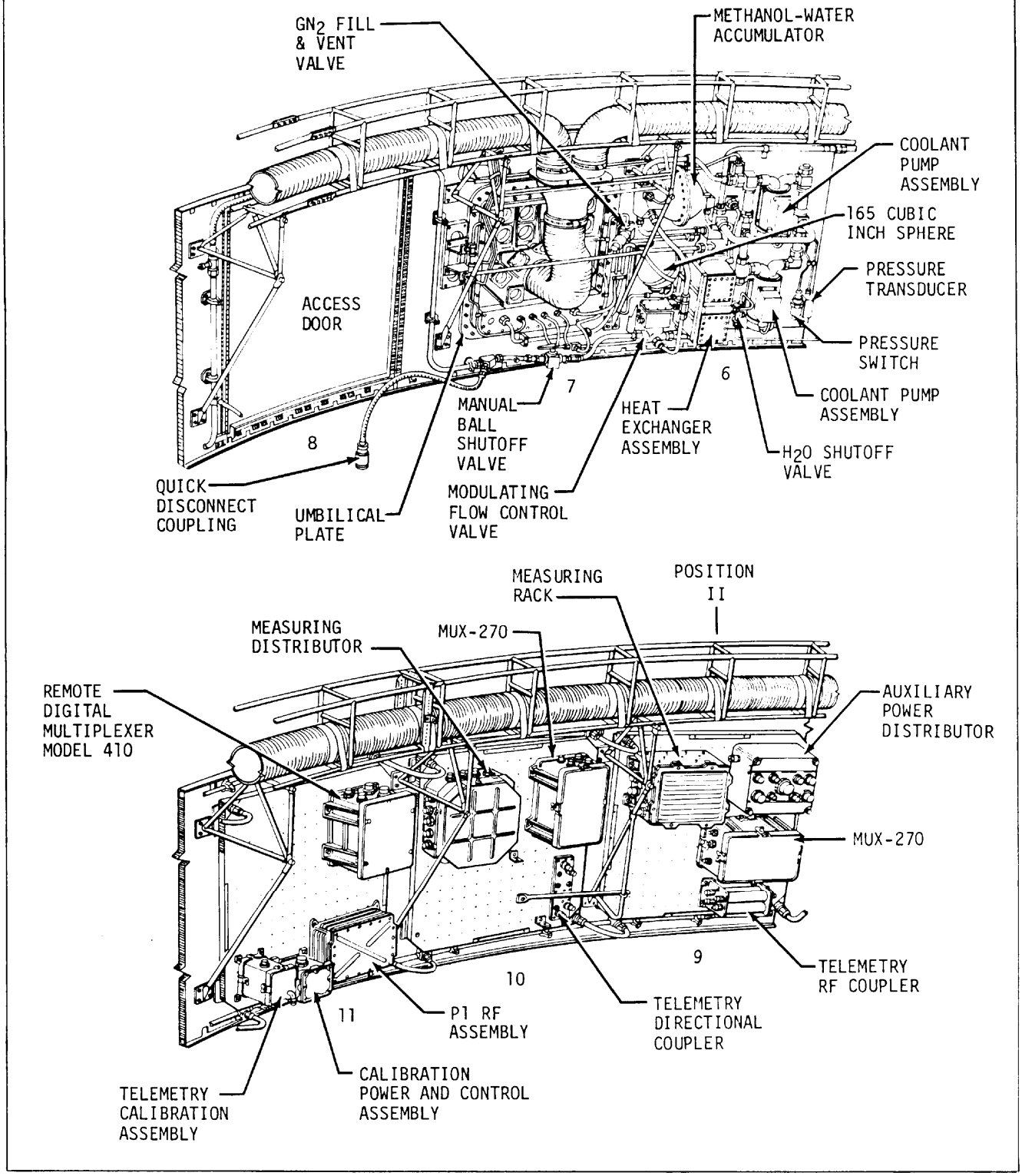
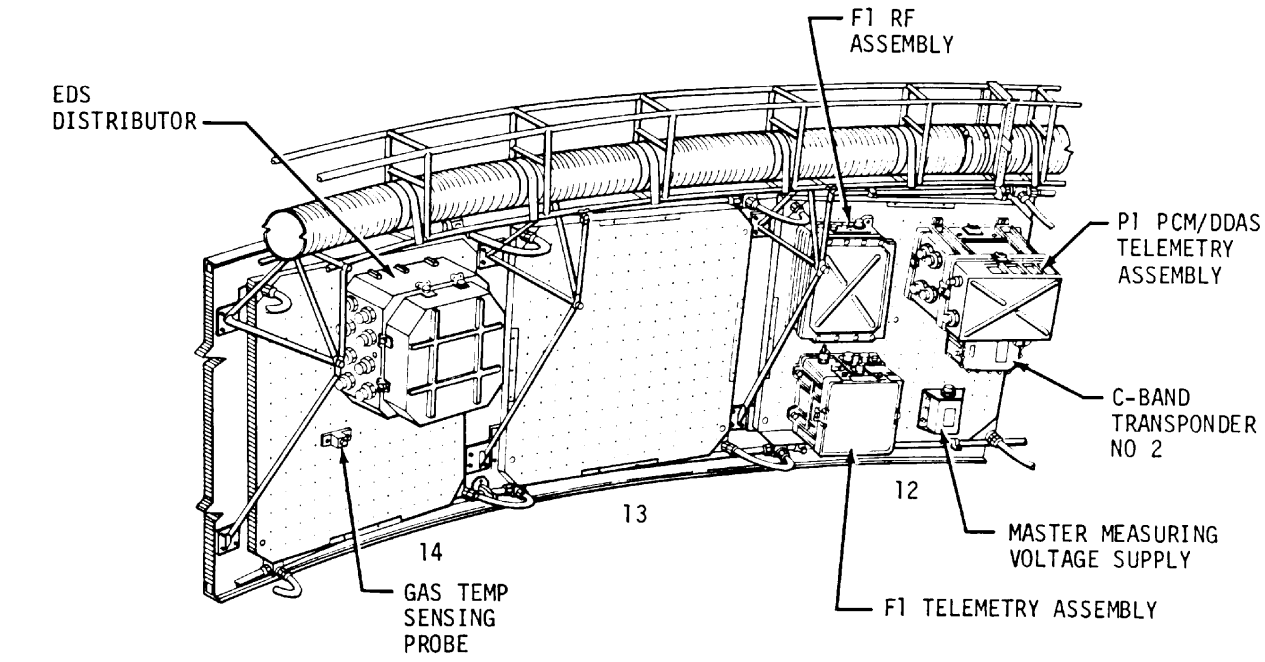


Figure 7-4 (Sheet 3 of 5)

INSTRUMENT UNIT EQUIPMENT LOCATIONS



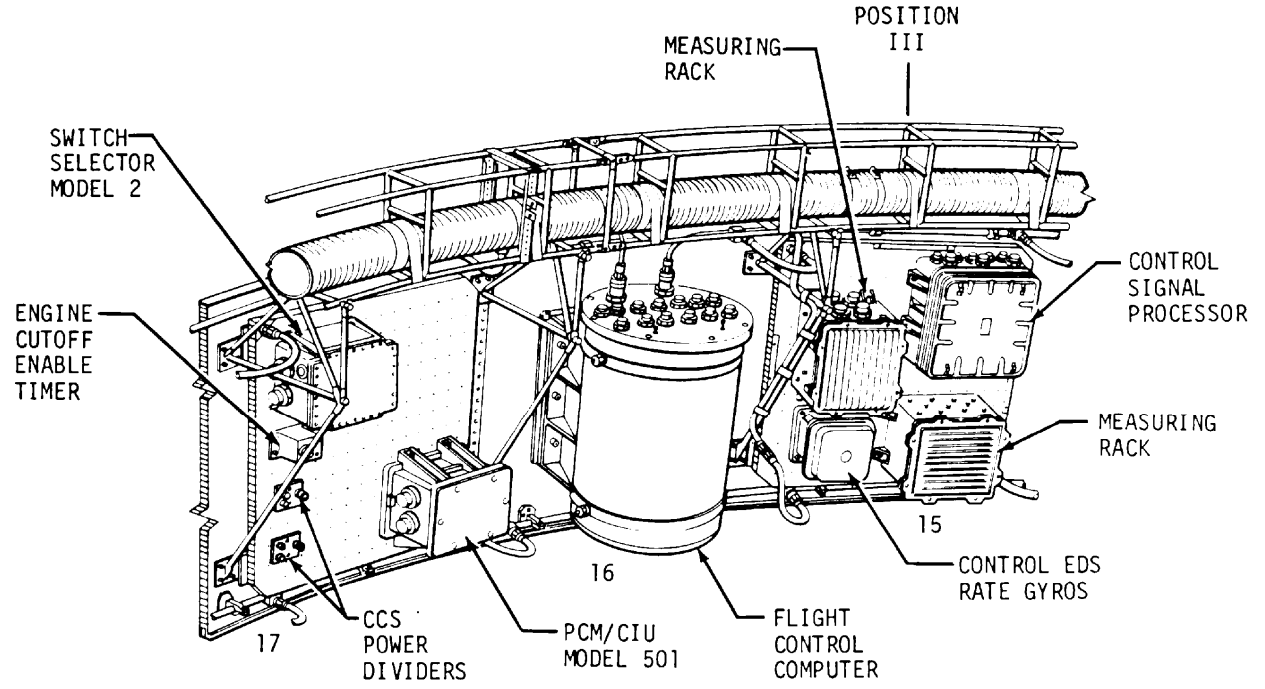


Figure 7-4 (Sheet 4 of 5)

INSTRUMENT UNIT EQUIPMENT LOCATIONS

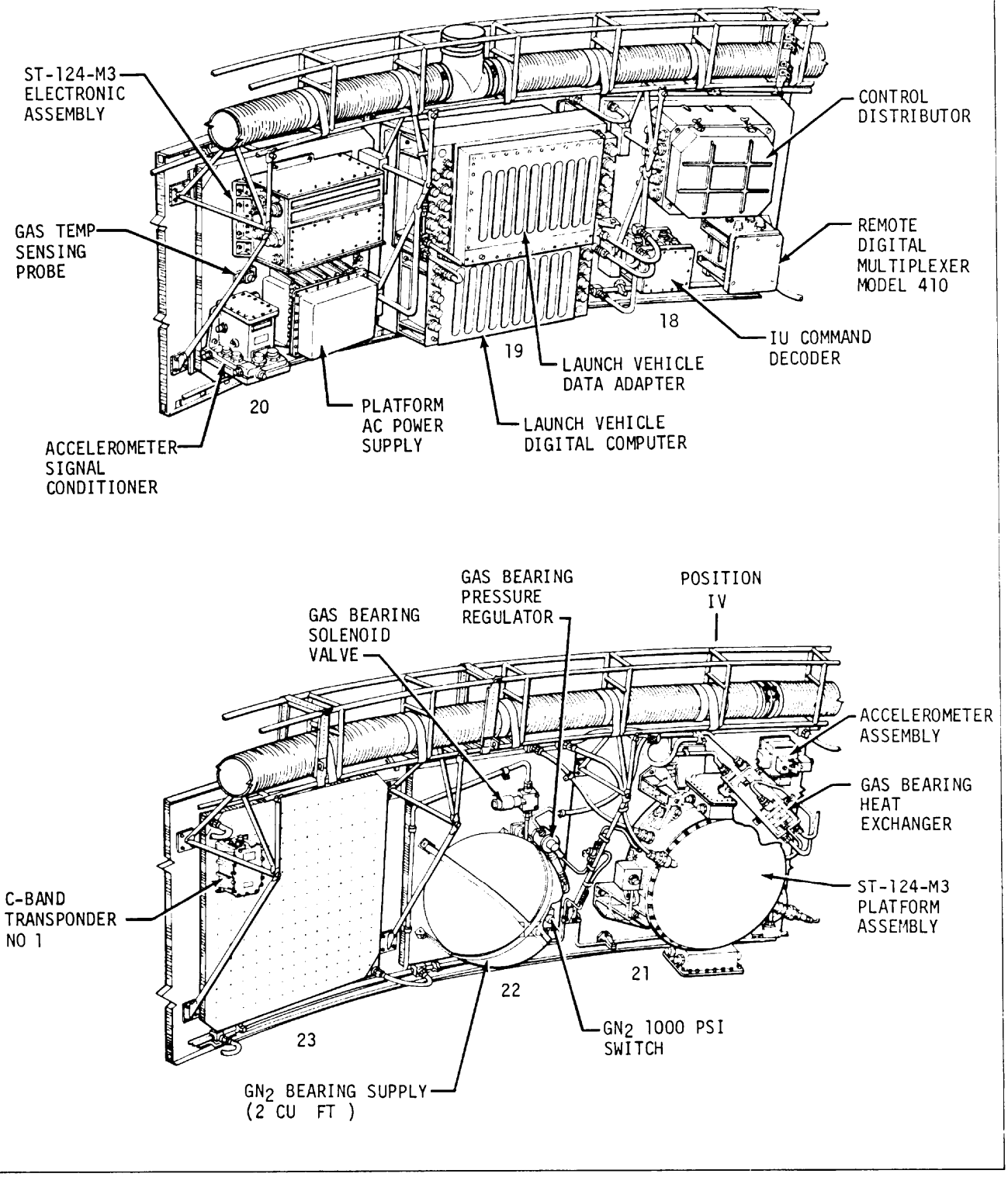
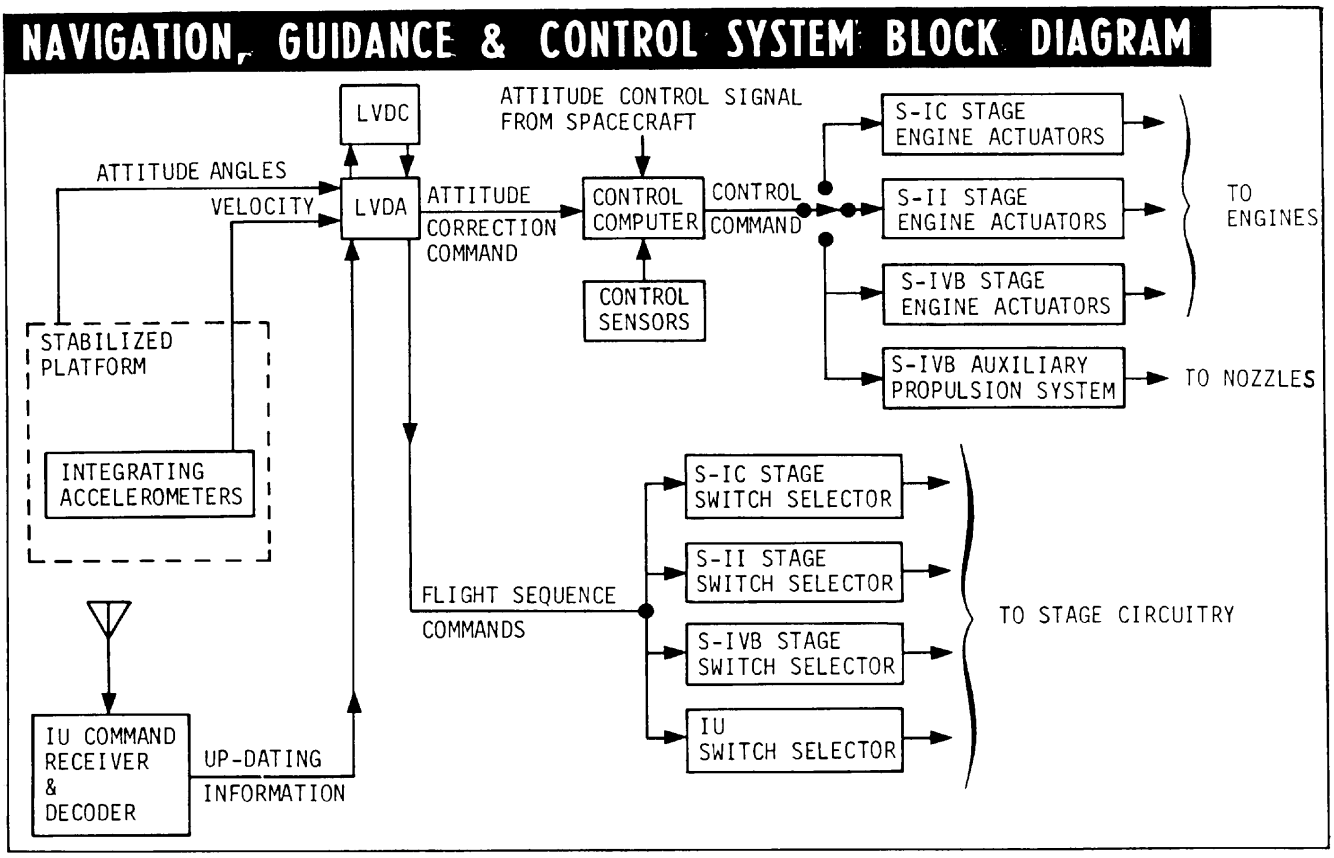


Figure 7-4 (Sheet 5 of 5)


NAVIGATION, GUIDANCE & CONTROL SYSTEM BLOCK DIAGRAM
LVDC
ATTITUDE CONTROL SIGNAL FROM SPACECRAFT
ATTITUDE ANGLES
VELOCITY
LVDA
ATTITUDE CORRECTION COMMAND
CONTROL COMPUTER
CONTROL COMMAND
CONTROL SENSORS
S-IC STAGE ENGINE ACTUATORS
S-II STAGE ENGINE ACTUATORS
S-IVB STAGE ENGINE ACTUATORS
TO ENGINES
S-IVB AUXILIARY PROPULSION SYSTEM
TO NOZZLES
STABILIZED PLATFORM
INTEGRATING ACCELEROMETERS
S-IC STAGE SWITCH SELECTOR
S-II STAGE SWITCH SELECTOR
S-IVB STAGE SWITCH SELECTOR
IU SWITCH SELECTOR
TO STAGE CIRCUITRY
FLIGHT SEQUENCE COMMANDS
IU COMMAND RECEIVER & DECODER
UP-DATING INFORMATION

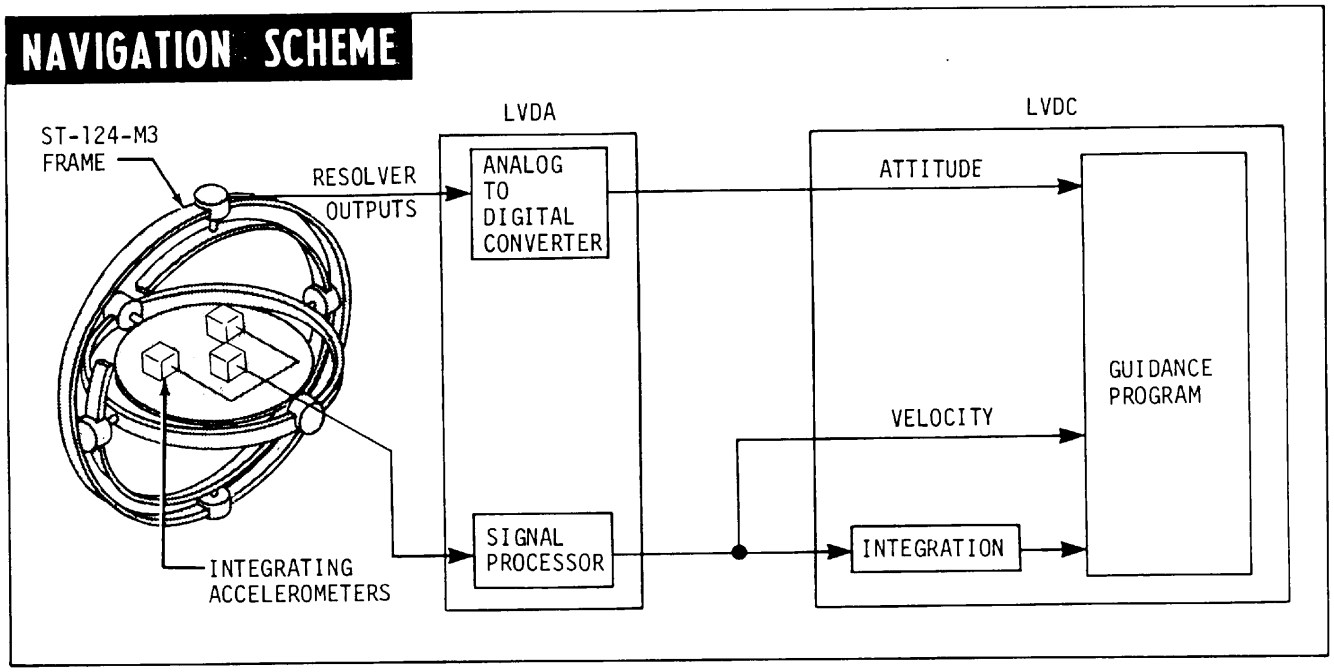
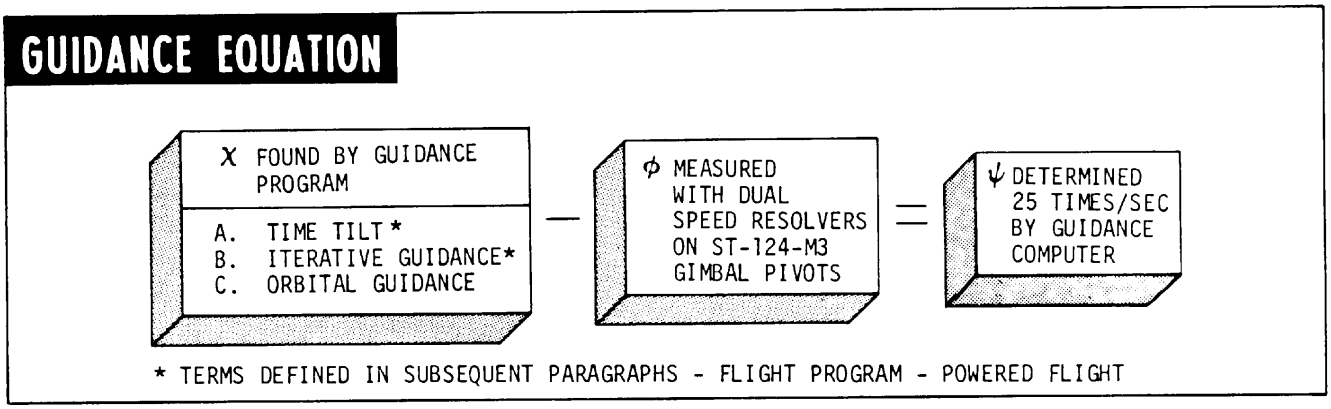

NAVIGATION SCHEME
ST-124-M3
FRAME
RESOLVER
OUTPUTS
LVDA
ANALOG
TO
DIGITAL
CONVERTER
LVDC
ATTITUDE
GUIDANCE
PROGRAM
VELOCITY
SIGNAL
PROCESSOR
INTEGRATION
INTEGRATING
ACCELEROMETERS

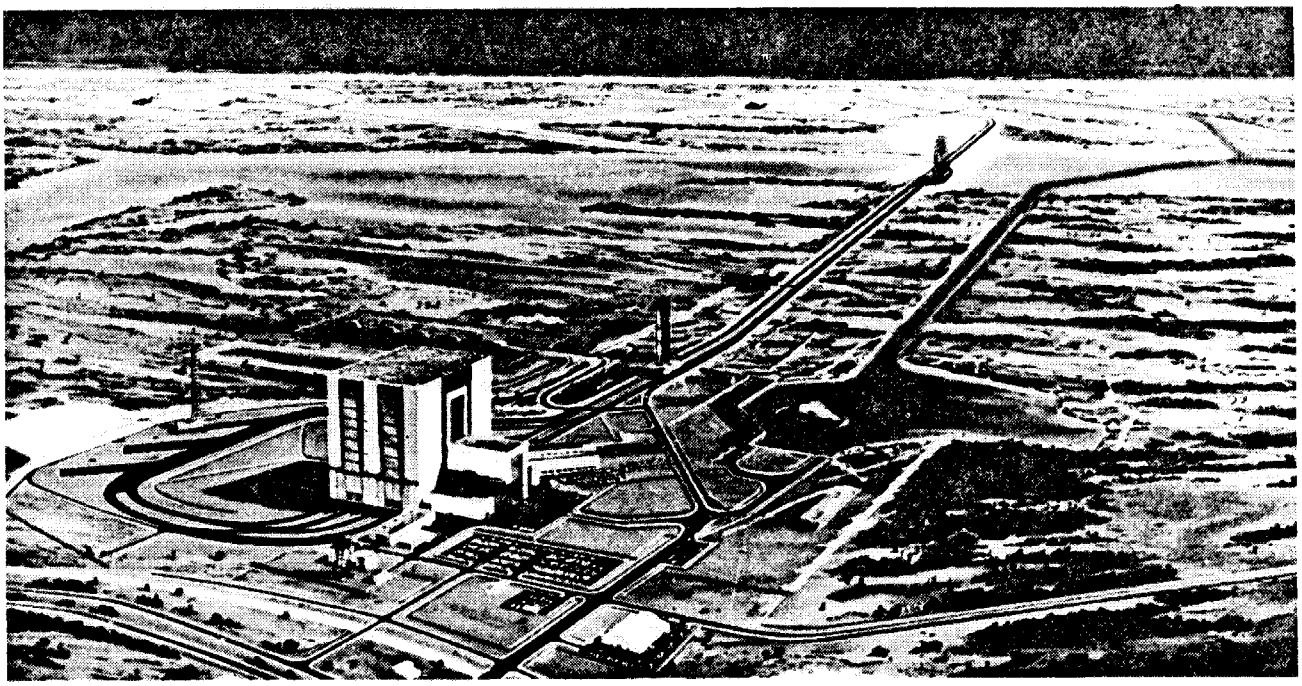
Figure 7-12

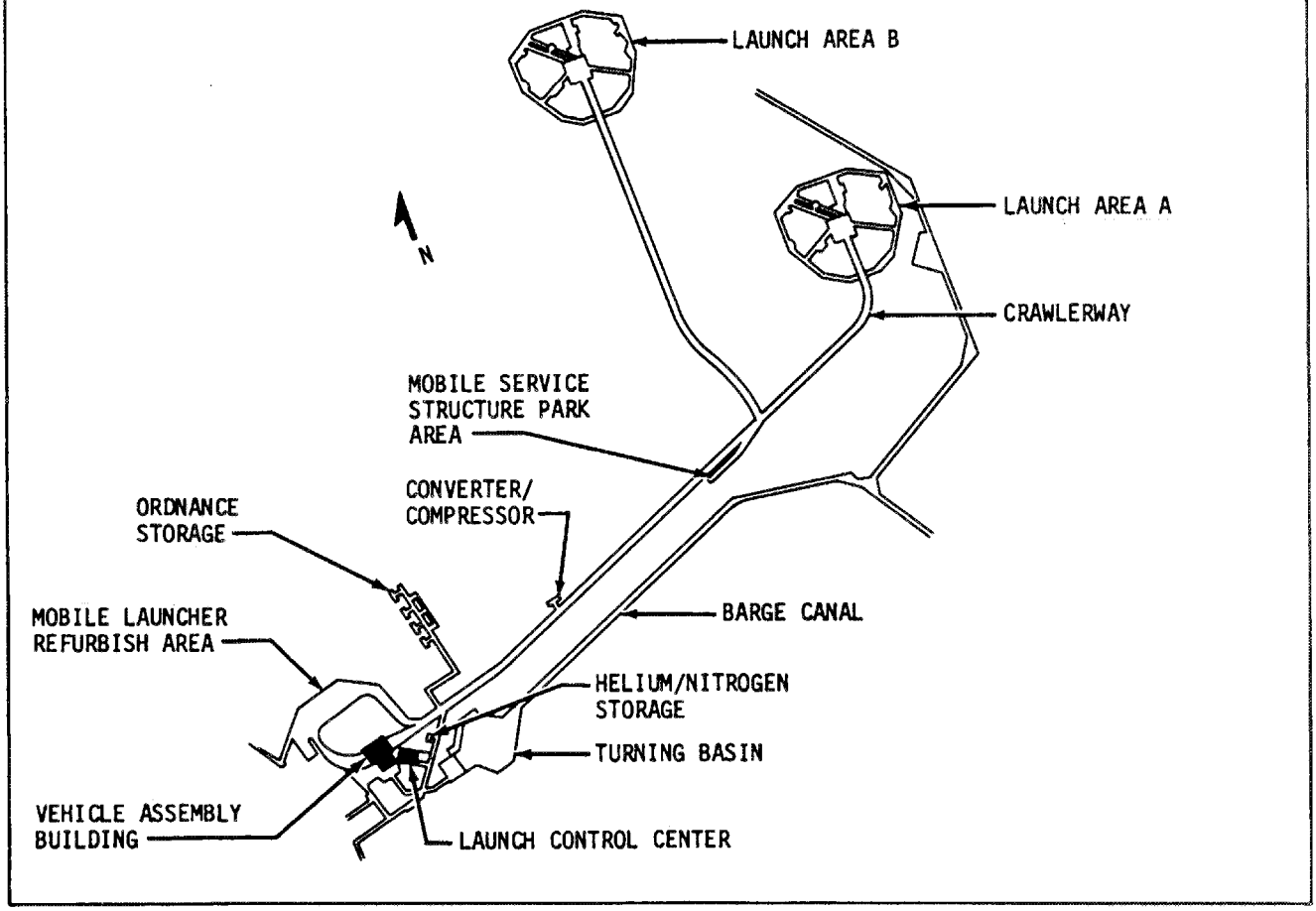

GUIDANCE EQUATION
χ FOUND BY GUIDANCE PROGRAM
A. TIME TILT *
B. ITERATIVE GUIDANCE*
C. ORBITAL GUIDANCE
—
φ MEASURED WITH DUAL SPEED RESOLVERS ON ST-124-M3 GIMBAL PIVOTS
=
ψ DETERMINED 25 TIMES/SEC BY GUIDANCE COMPUTER
* TERMS DEFINED IN SUBSEQUENT PARAGRAPHS - FLIGHT PROGRAM - POWERED FLIGHT

LAUNCH VEHICLE DIGITAL COMPUTER CHARACTERISTICS	
ITEM	DESCRIPTION
Type	General Purpose, Digital, Stored Program
Memory	Random Access, Ferrite (Torodial) Core, with a Capacity of 32,768 words of 28 Bits each
Speed	Serial Processing at 512,000 Bits Per Second
Word Make-Up	Memory = 28 Bits Data = 26 Bits Plus 2 Parity Bits Instruction = 13 Bits Plus 1 Parity Bit
Programming	18 Instruction Codes 10 Arithmetic 6 Program Control 1 Input/Output 1 Store
Timing	Computer Cycle = 82.03 μ sec. Bit Time = 1.95 μ sec. Clock Time = 0.49 μ sec.
Input/Output	External, Program Controlled

LAUNCH VEHICLE DATA ADAPTER CHARACTERISTICS	
ITEM	DESCRIPTION
Input/Output Rate	Serial Processing at 512,000 Bits Per Second
Switch Selector	8 Bit Input 15 Bit Output
Telemetry Command Receiver	14 Bits for Input Data
Data Transmitter	38 Data and Identification Bits Plus Validity Bit and Parity Bit
Computer Interface Unit	15 Bits Address Plus 1 Data Request Bit 10 Bits for Input Data Plus 1 Bit for Data Ready Interrupt
Delay Lines	3 Four-Channel Delay Lines for Normal Operation 1 Four-Channel Delay Line for Telemetry Operations
Output to Launch Computer	41 Data and Identification Bits Plus Discrete Outputs
Input From RCA-110 GCC	14 Bits for Data Plus Interrupt

LAUNCH COMPLEX 39





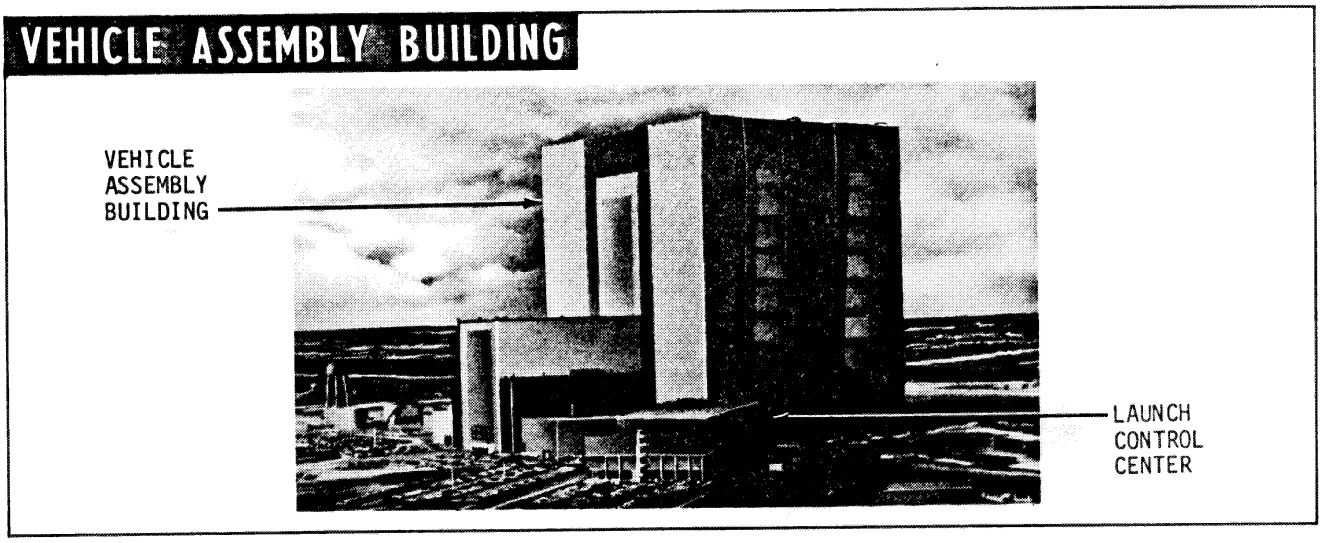
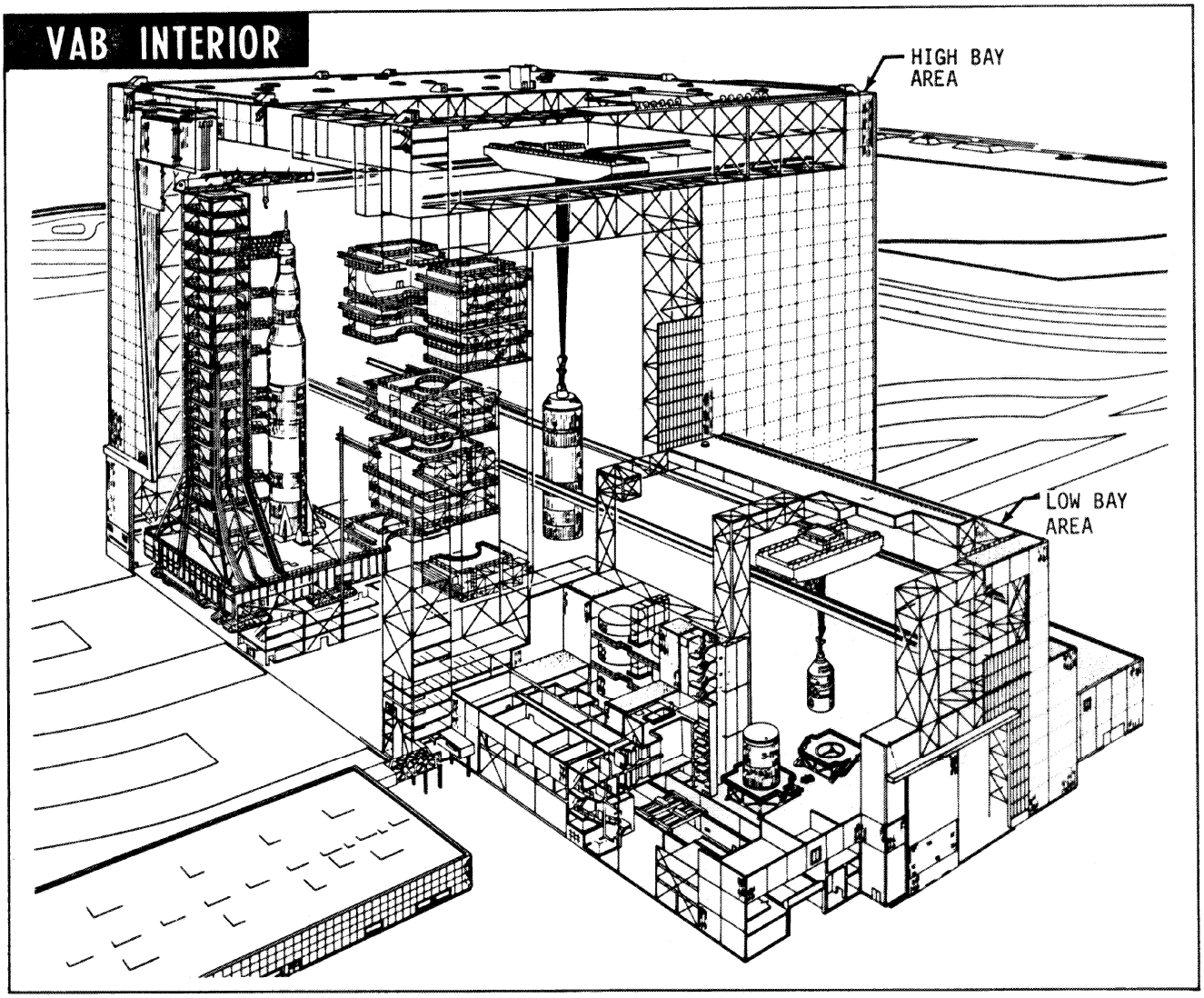
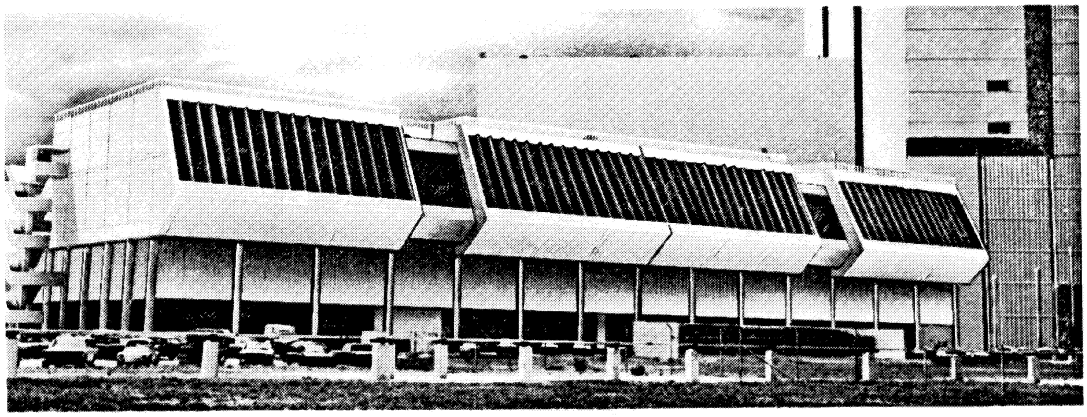
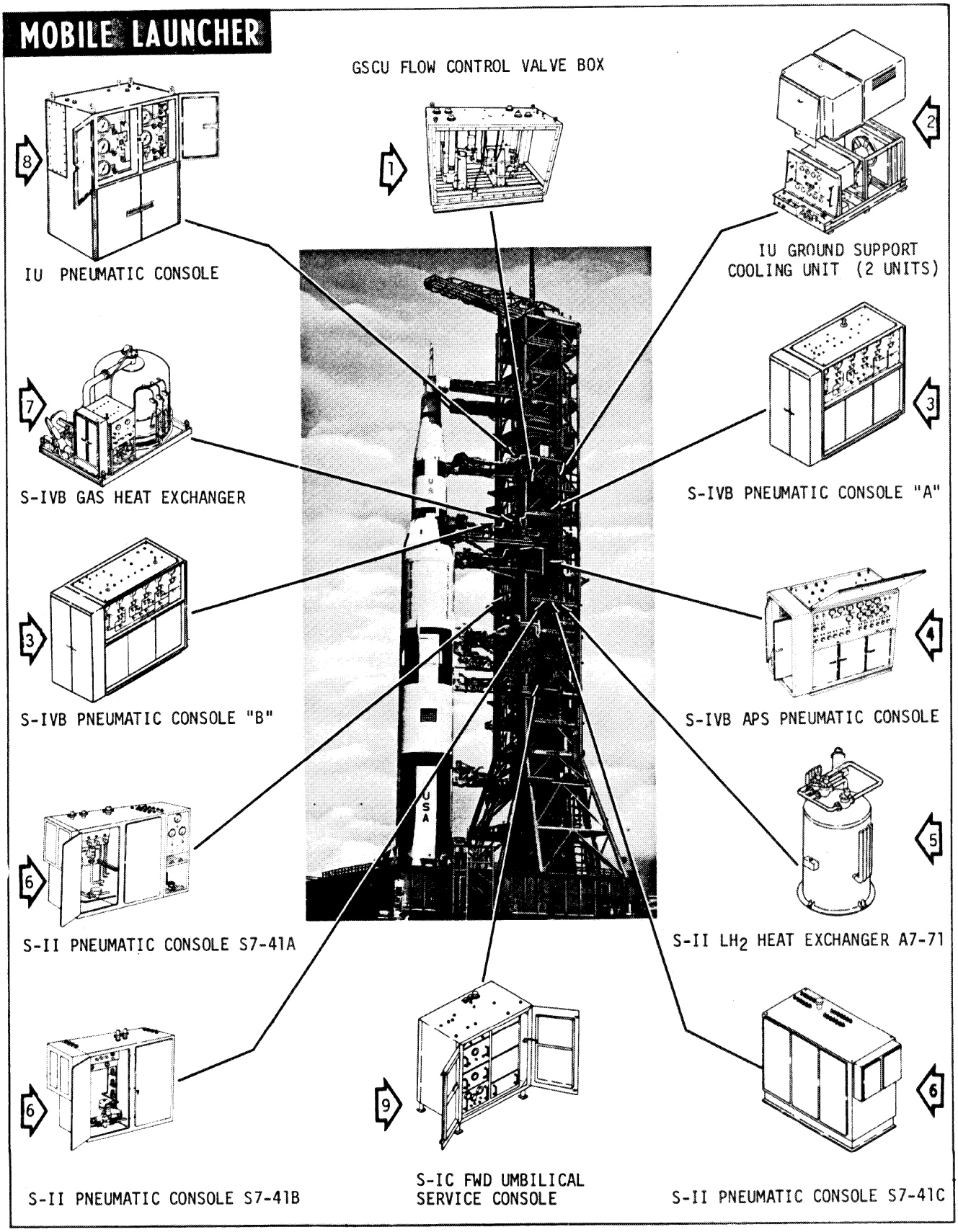

VEHICLE ASSEMBLY BUILDING
VEHICLE ASSEMBLY BUILDING
LAUNCH CONTROL CENTER

Figure 8-2


VAB INTERIOR
HIGH BAY AREA
LOW BAY AREA

LCC EXTERIOR




MOBILE LAUNCHER
GSCU FLOW CONTROL VALVE BOX
IU PNEUMATIC CONSOLE
IU GROUND SUPPORT COOLING UNIT (2 UNITS)
S-IVB GAS HEAT EXCHANGER
S-IVB PNEUMATIC CONSOLE "A"
S-IVB PNEUMATIC CONSOLE "B"
S-IVB APS PNEUMATIC CONSOLE
S-II PNEUMATIC CONSOLE S7-41A
S-II LH_2 HEAT EXCHANGER A7-71
S-II PNEUMATIC CONSOLE S7-41B
S-IC FWD UMBILICAL SERVICE CONSOLE
S-II PNEUMATIC CONSOLE S7-41C

MOBILE LAUNCHER

1. GSCU Flow Control Valve Box
   Selects either GSCU for operation of one unit while the other recirculates.

2. Ground Support Cooling Unit
   Supplies water-methanol to the heat exchanger in the IU thermal conditioning system to absorb heat in the IU generated by electronic equipment.

3. S-IVB Pneumatic Console A&B
   Regulates and controls helium and nitrogen gases for leak testing, functional checkout, propellant loading, purge, and propellant unloading.

4. S-IVB APS Pneumatic Console
   Regulate and distribute helium and nitrogen gases during checkout and propellant loading.

5. S-II LH_2 Heat Exchanger A7-71
   Provides gases to the S-IC stage for the following:
   1. Fuel tank pressurization
   2. LOX tank pre-pressurization
   3. Thrust Chamber jacket chilldown

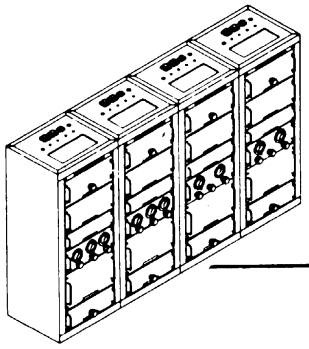
6. S-II Pneumatic Consoles S7-41A, B, & C
   Regulate, control, and monitor gases for S-II stage during standby, prelaunch, and launch.

7. S-IVB Gas Heat Exchanger
   Supplies cold helium or hydrogen for the following:
   1. Lox and Fuel Tank Pre-Pressurization
   2. Thrust chamber jacket chilldown
   3. Pressurize engine turbine start bottle

8. IU Pneumatic Console
   Regulates, monitors, and controls pneumatic pressure to pressurize, checkout, and test the air bearing spheres and related pneumatic and electro-mechanical circuitry.

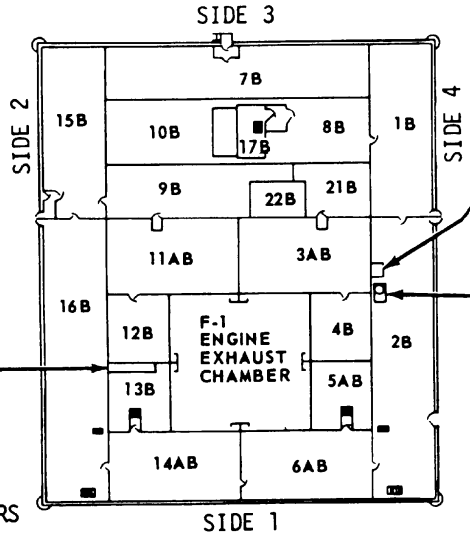
9. S-IC Forward Umbilical Service Console
   Supplies nitrogen from three regulation modules to S-IC stage pneumatic systems through the forward umbilical plate.

MOBILE LAUNCHER LEVEL A AND B

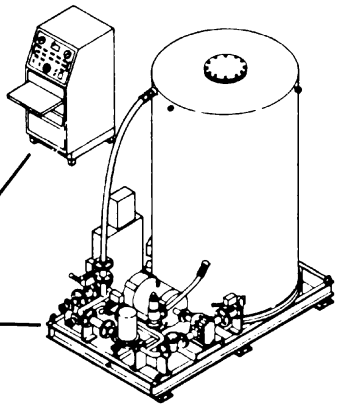


S-IC PNEUMATIC CHECKOUT RACKS

REGULATES CONTROLS, AND MONITORS NITROGEN FOR TEST AND CHECKOUT OF PRESSURE SWITCHES AND VALVES IN STAGE PROPULSION SYSTEM.

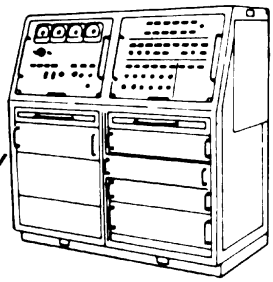


SIDE 1
LEVEL B (LOWER)

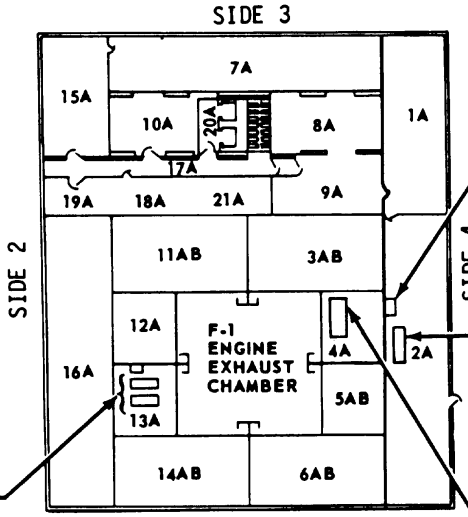


S-IC INERT PREFILL UNIT

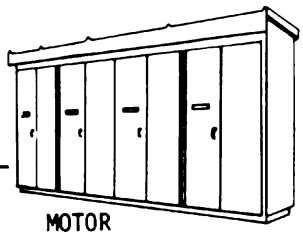
SUPPLIES ETHYLENE GLYCOL TO F-1 ENGINE FUEL JACKETS TO ELIMINATE ENTRAPPED AIR.



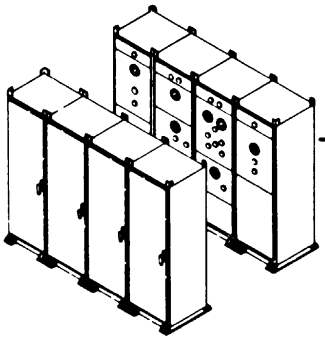
SYSTEM CHECKOUT CONSOLE



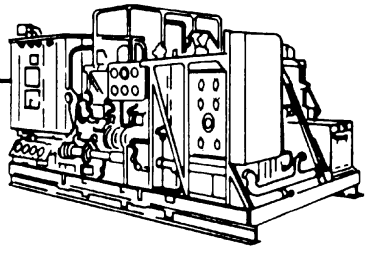
SIDE 1
LEVEL A (UPPER)



MOTOR CONTROL CENTER



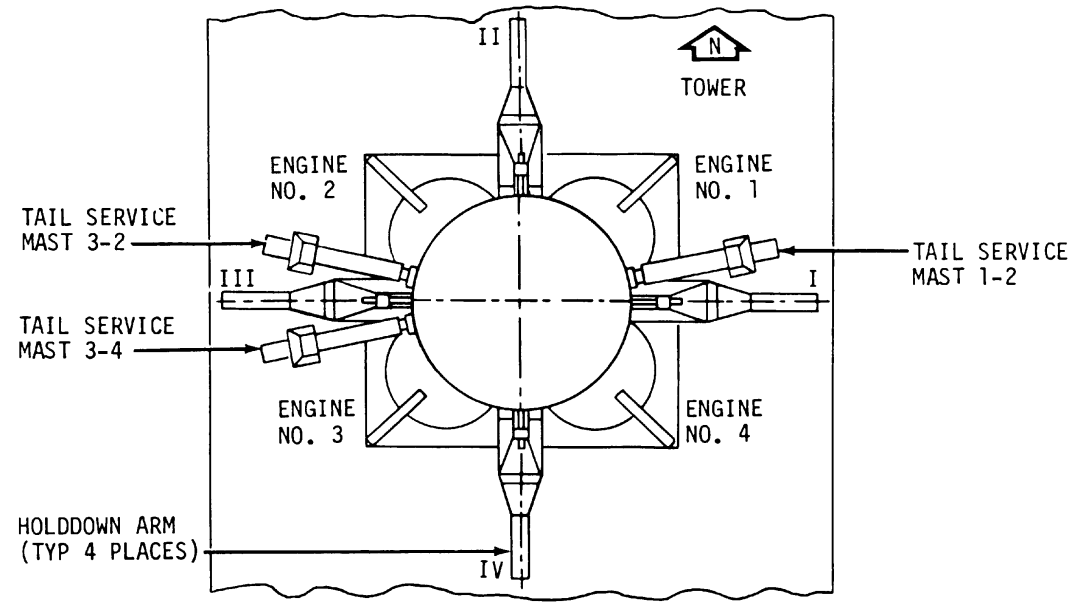
S-IC PNEUMATIC CONSOLE
REGULATES FACILITY GASES
SUPPLIES OPERATING PRESSURES TO S-IC STAGE AND S-IC PNEUMATIC CHECKOUT RACKS



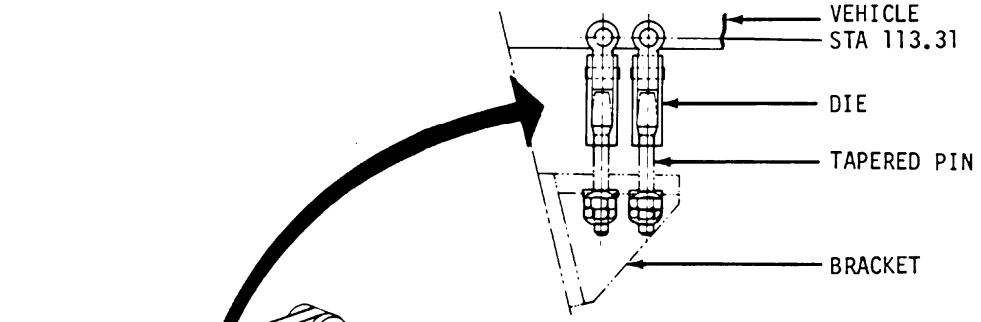
HYDRAULIC POWER UNIT

S-IC HYDRAULIC SUPPLY AND CHECKOUT UNIT
GIMBALS FOUR OUTBOARD F-1 ENGINES
CHECKS OUT "THRUST OK" PRESSURE SWITCHES
CONTROLS F-1 ENGINE VALVES

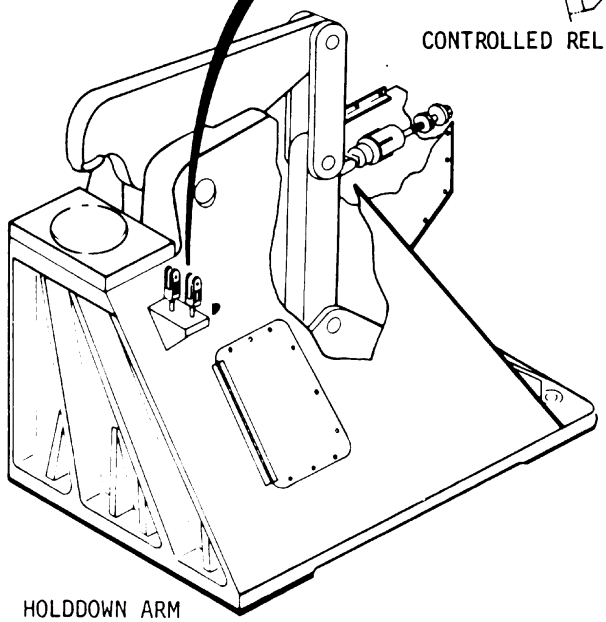
HOLDDOWN ARMS/TAIL SERVICE MAST



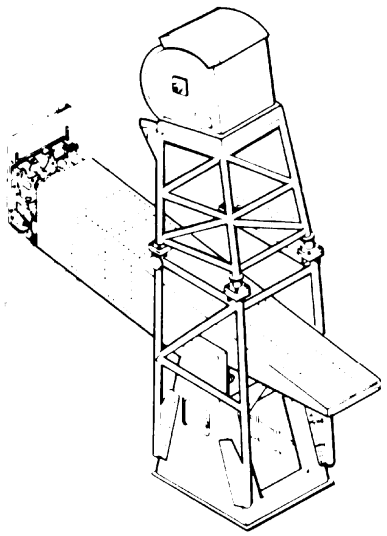
ENGINE/HOLDDOWN ARM/TAIL SERVICE MAST ORIENTATION



CONTROLLED RELEASE MECHANISMS



HOLDDOWN ARM



TAIL SERVICE MAST

MOBILE LAUNCHER SERVICE ARMS

1. S-IC Intertank (preflight). Provides lox fill and drain interfaces. Umbilical withdrawal by pneumatically driven compound parallel linkage device. Arm may be reconnected to vehicle from LCC. Retract time is 8 seconds. Reconnect time is approximately 5 minutes.

2. S-IC Forward (preflight). Provides pneumatic, electrical, and air-conditioning interfaces. Umbilical withdrawal by pneumatic disconnect in conjunction with pneumatically driven block and tackle/lanyard device. Secondary mechanical system. Retracted at T-19 seconds. Retract time is 8 seconds.

3. S-II Aft (preflight). Provides access to vehicle. Arm retracted prior to liftoff as required.

4. S-II Intermediate (inflight). Provides LH_2 and lox transfer, vent line, pneumatic, instrument cooling, electrical, and air-conditioning interfaces. Umbilical withdrawal systems same as S-IVB Forward with addition of a pneumatic cylinder actuated lanyard system. This system operates if primary withdrawal system fails. Retract time is 6.4 seconds (max).

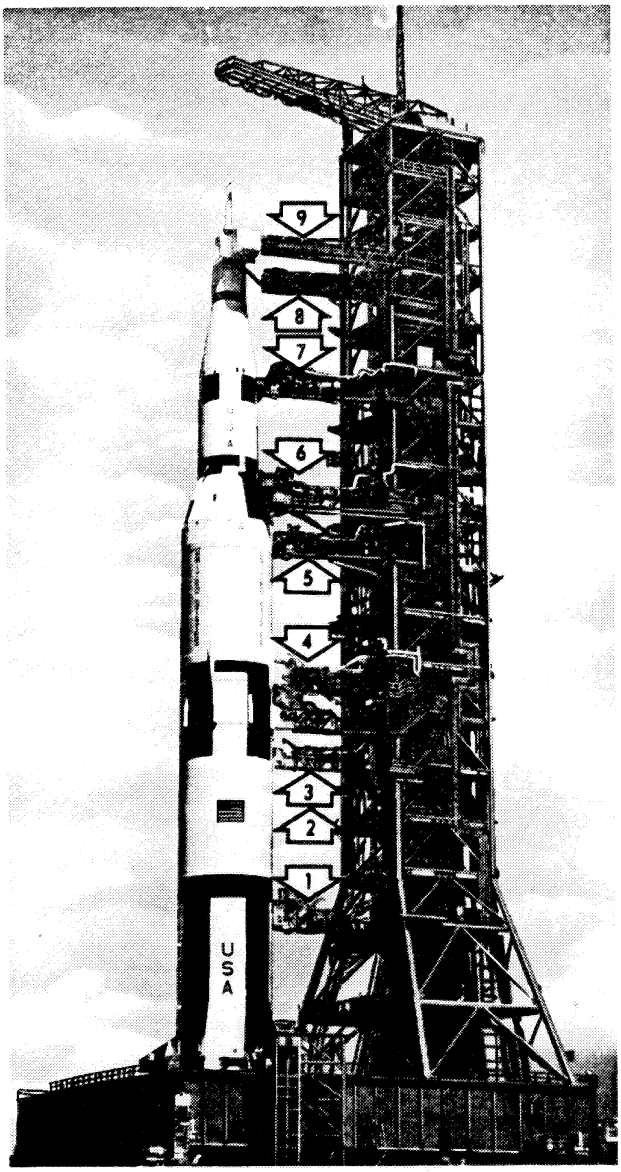
5. S-II Forward (inflight). Provides GH_2 vent, electrical, and pneumatic interfaces. Umbilical withdrawal systems same as S-IVB Forward. Retract time is 7.4 seconds (max).

6. S-IVB Aft (inflight). Provides LH_2 and lox transfer, electrical, pneumatic, and air-conditioning interfaces. Umbilical withdrawal systems same as S-IVB Forward. Also equipped with line handling device. Retract time is 7.7 seconds (max).

7. S-IVB Forward (inflight). Provides fuel tank vent, electrical, pneumatic, air-conditioning, and preflight conditioning interfaces. Umbilical withdrawal by pneumatic disconnect in conjunction with pneumatic/hydraulic redundant dual cylinder system. Secondary mechanical system. Arm also equipped with line handling device to protect lines during withdrawal. Retract time is 8.4 seconds (max).

8. Service Module (inflight). Provides air-conditioning, vent line, coolant, electrical, and pneumatic interfaces. Umbilical withdrawal by pneumatic/mechanical lanyard system with secondary mechanical system. Retract time is 9.0 seconds (max).

9. Command Module Access Arm (preflight). Provides access to spacecraft through environmental chamber. Arm may be retracted or extended from LCC. Retracted 12° park position until T-4 minutes. Extend time is 12 seconds from this position.



LAUNCH PAD A, LC-39

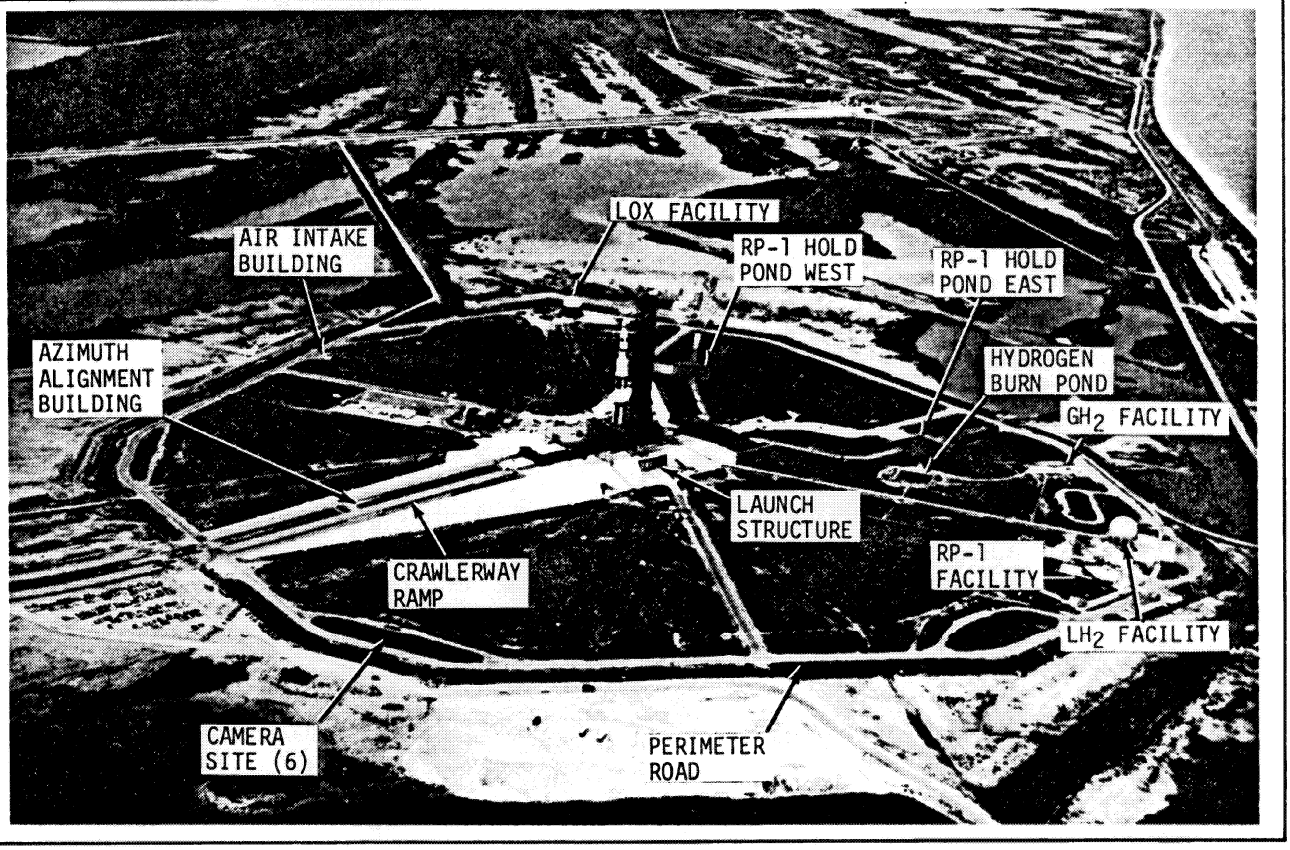
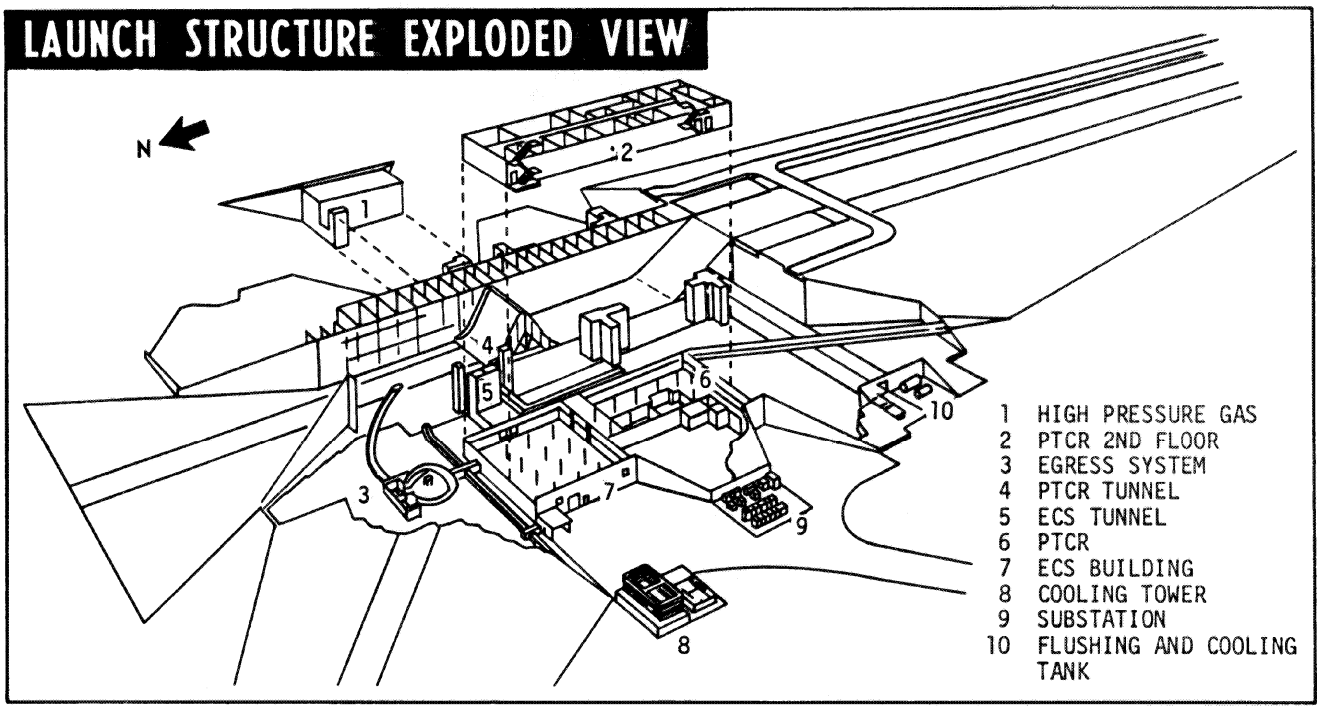
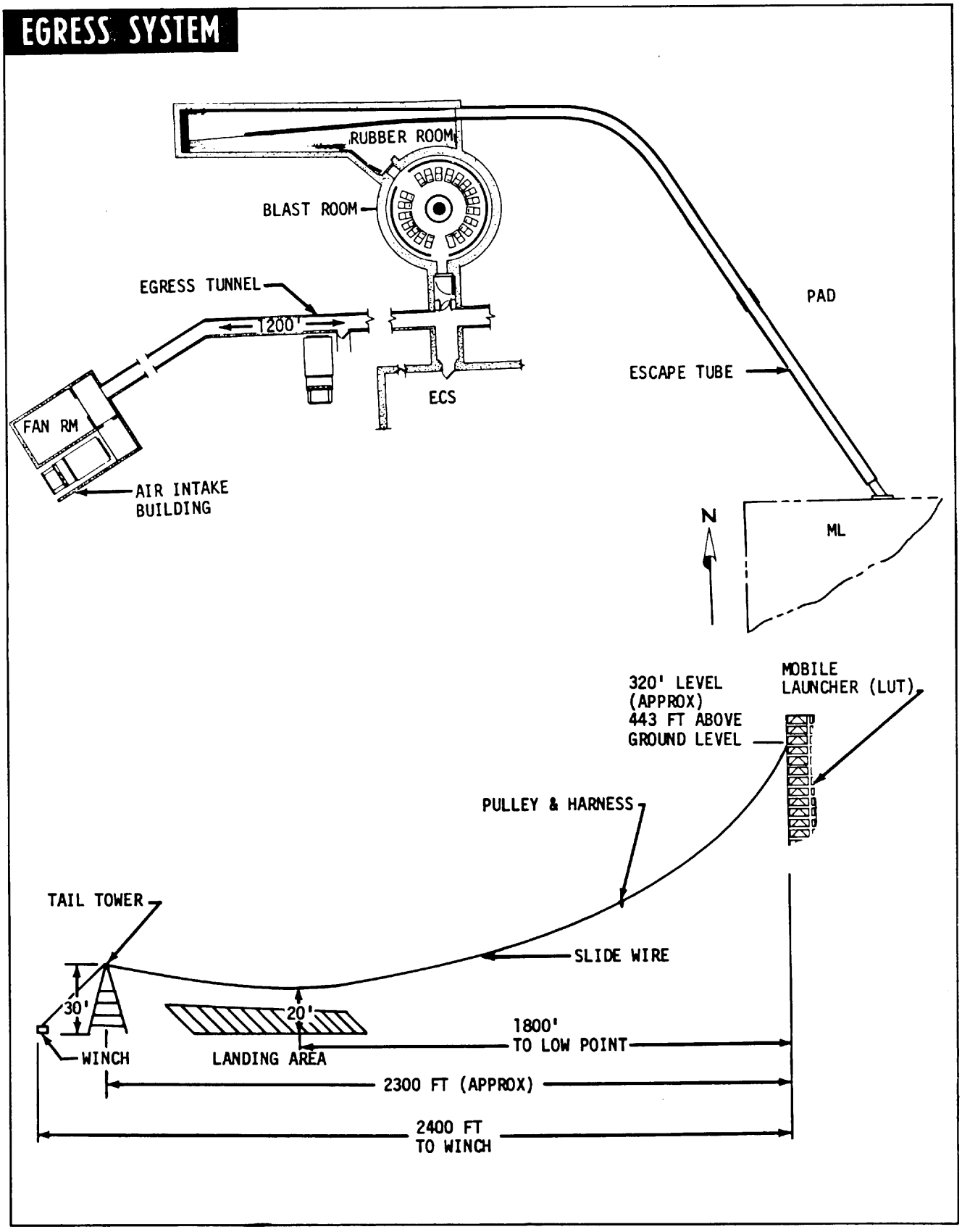
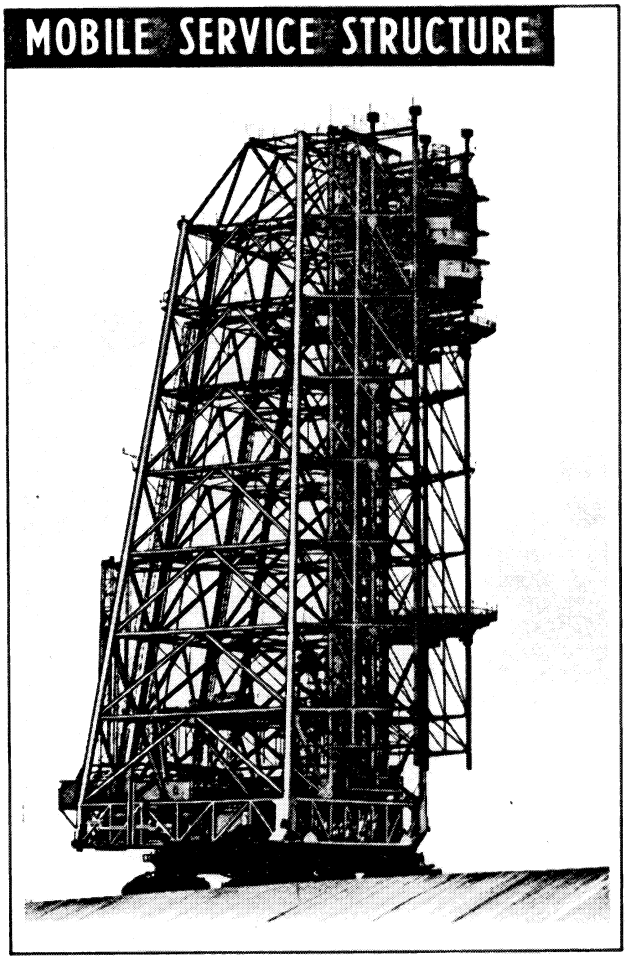


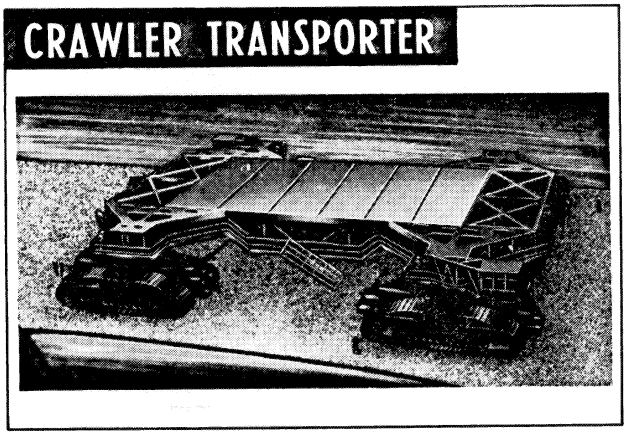
Figure 8-9

LAUNCH STRUCTURE EXPLODED VIEW

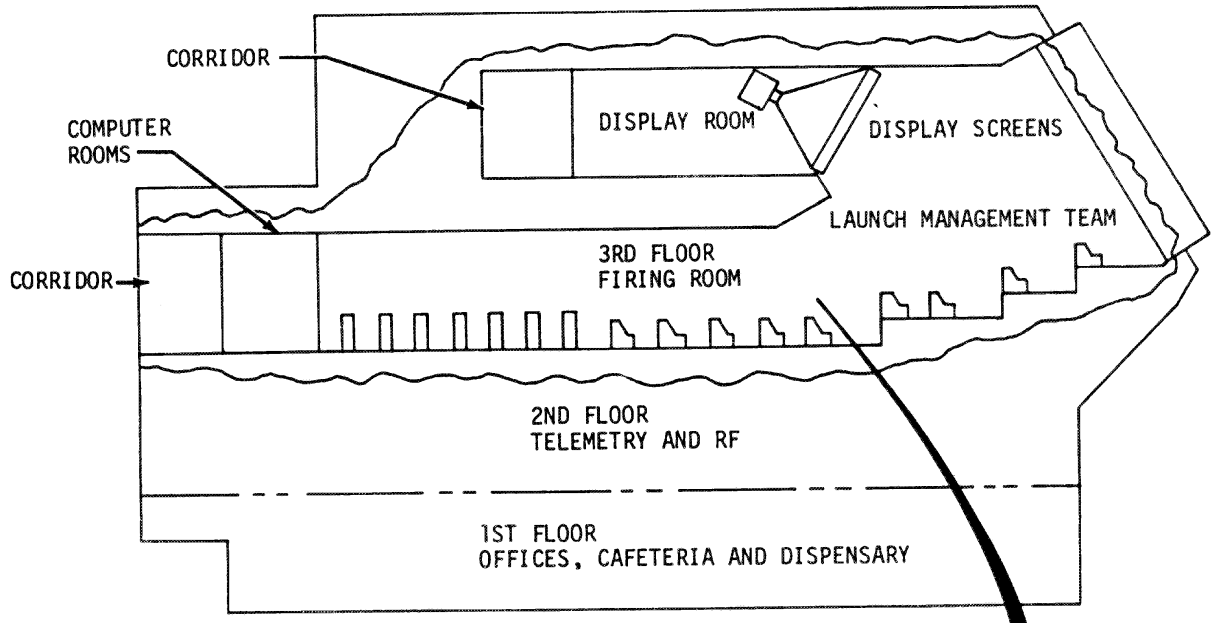



EGRESS SYSTEM
RUBBER ROOM
BLAST ROOM
EGRESS TUNNEL
1200'
ECS
PAD
ESCAPE TUBE
FAN RM
AIR INTAKE BUILDING
N
ML
320' LEVEL (APPROX) 443 FT ABOVE GROUND LEVEL
MOBILE LAUNCHER (LUT)
PULLEY & HARNESS
TAIL TOWER
SLIDE WIRE
30'
20'
1800' TO LOW POINT
WINCH
LANDING AREA
2300 FT (APPROX)
2400 FT TO WINCH

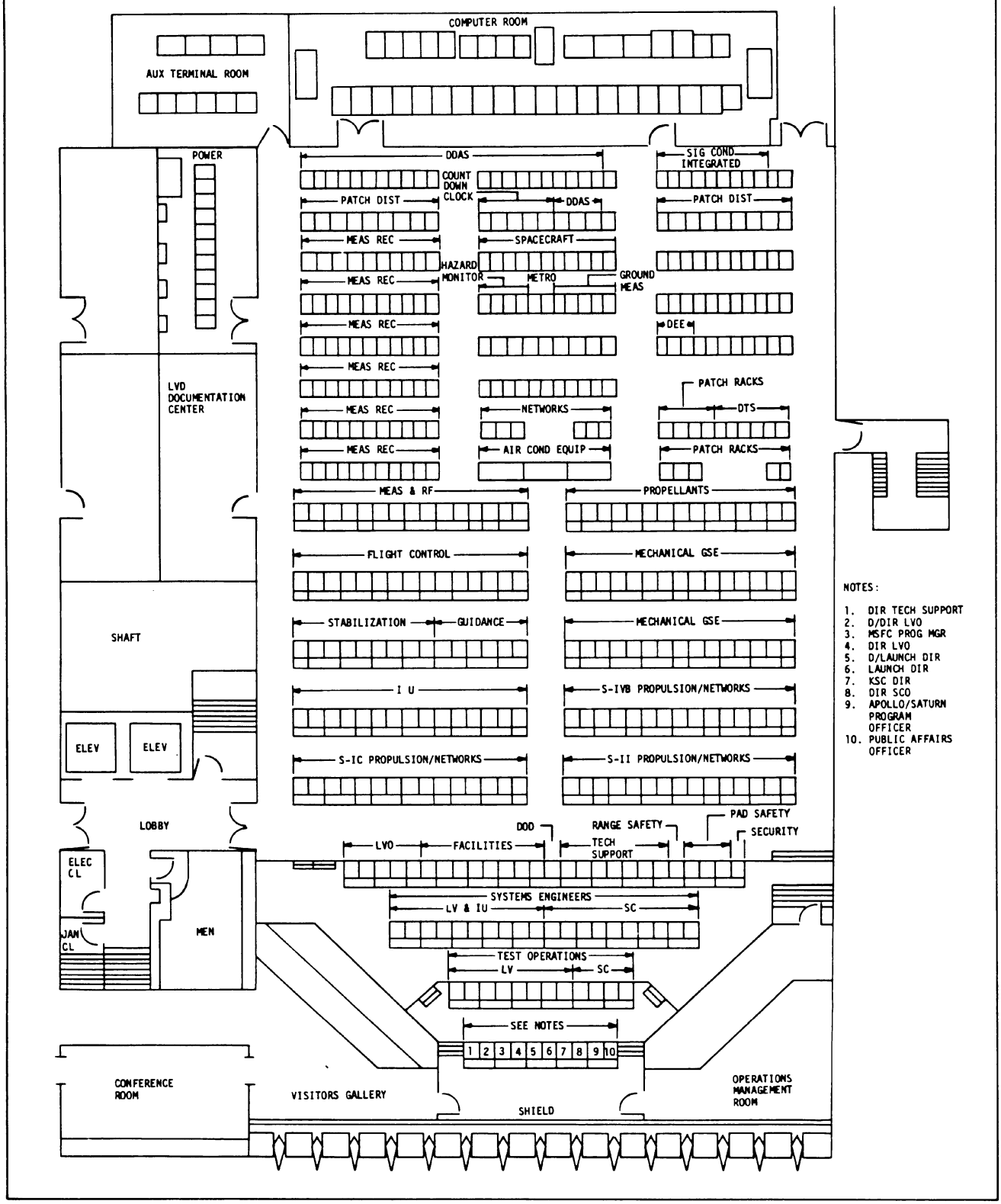

MOBILE SERVICE STRUCTURE


CRAWLER TRANSPORTER

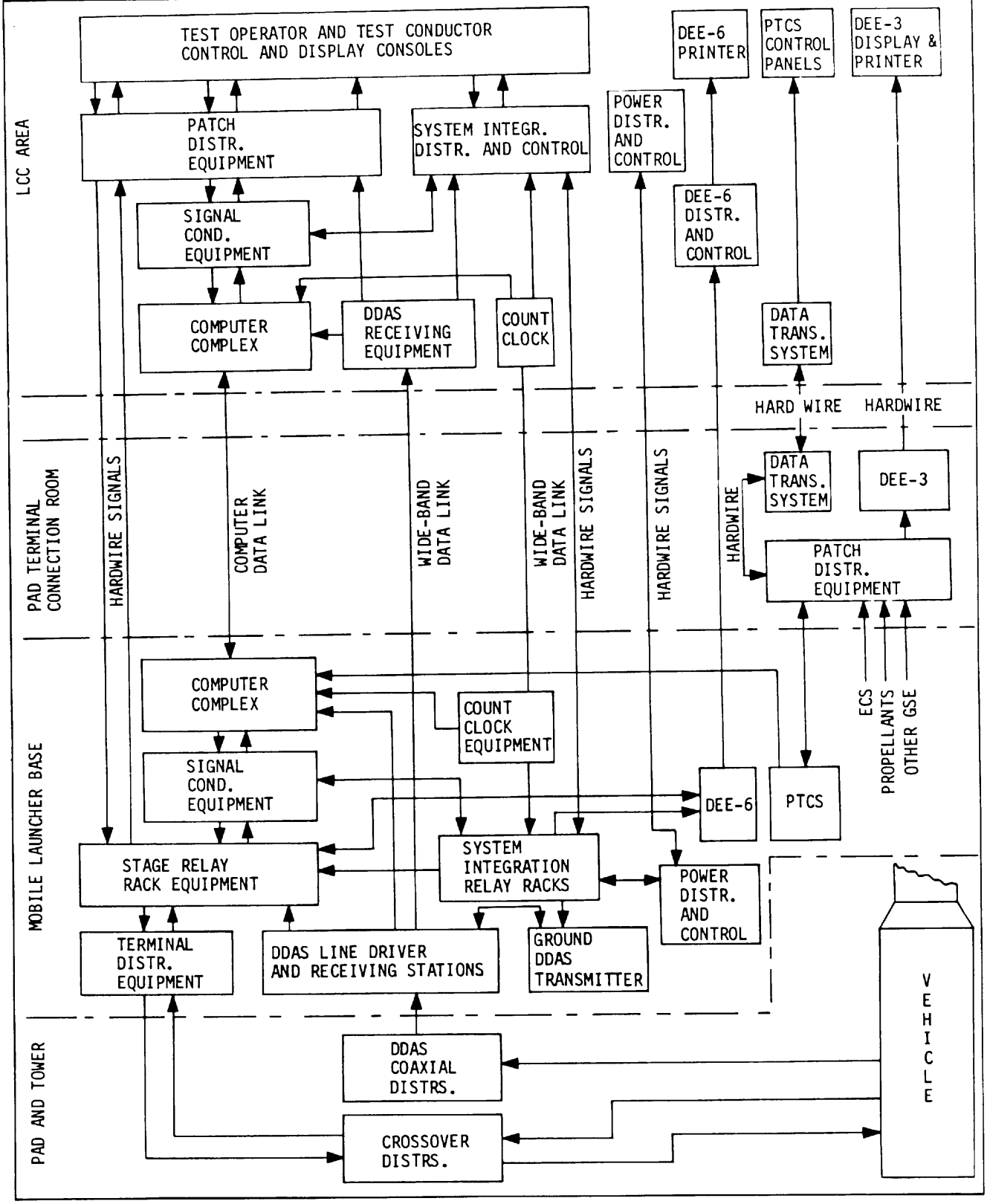
LCC FACILITY LAYOUT



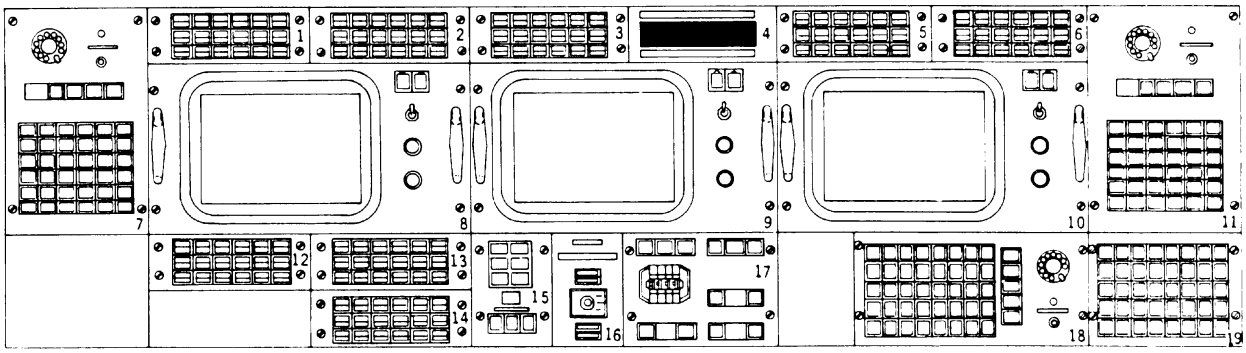
FIRING ROOM (TYPICAL)



FUNCTIONAL INTERCONNECT DIAGRAM

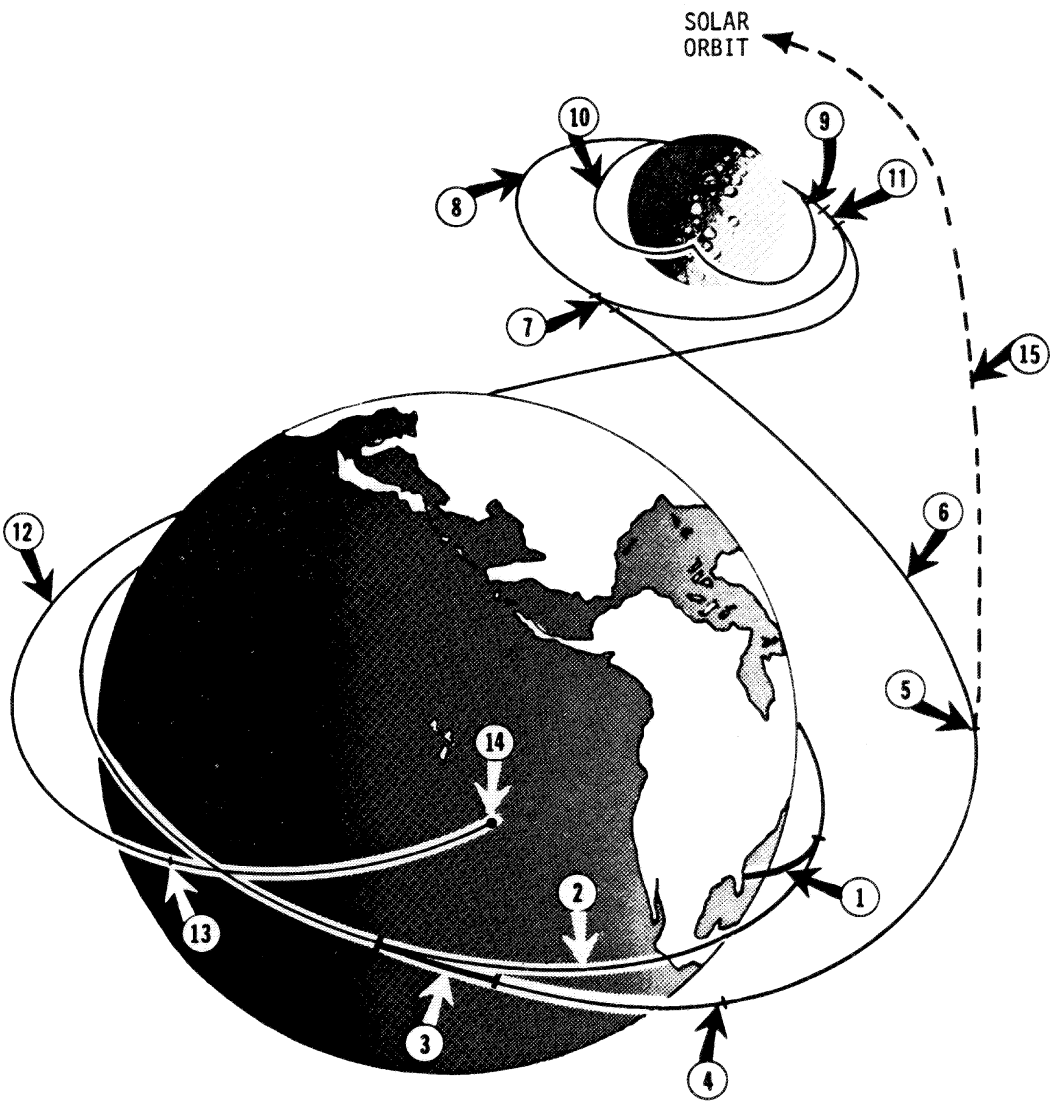


TYPICAL CONFIGURATION - BOOSTER SYSTEMS ENGINEERS CONSOLE



1. EVENT INDICATORS (S-IC/S-II)
2. EVENT INDICATOR (VEHICLE TELEMETRY STATUS, EDS, COMMAND, RANGE SAFETY)
3. EVENT INDICATORS (S-IVB)
4. GROUND ELAPSED TIME MODULE
5. EVENT INDICATORS (GUIDANCE AND NAVIGATION, ATTITUDE CONTROL)
6. EVENT INDICATORS (GUIDANCE AND NAVIGATION, ATTITUDE CONTROL)
7. COMMUNICATIONS MODULE
8. TV MONITOR
9. TV MONITOR
10. TV MONITOR
11. COMMUNICATIONS MODULE
12. COMMAND MODULE
13. COMMAND MODULE
14. COMMAND MODULE
15. STATUS REPORT MODULE
16. ABORT REQUEST MODULE
17. MANUAL SELECT KEYBOARD
18. COMMUNICATIONS MODULE
19. SUMMARY MESSAGE ENABLE KEYBOARD

TRAJECTORY PROFILE FOR A LUNAR LANDING MISSION



1. BOOST TO EARTH ORBIT- S-IC, S-II, AND S-IVB OPERATION
2. COAST IN EARTH ORBIT
3. S-IVB TRANSLUNAR INJECTION BOOST
4. INITIATE TRANSPOSITION AND DOCKING MANEUVER
5. LV/SC FINAL SEPARATION
6. TRANSLUNAR COAST
7. SM DEBOOST TO CIRCULAR LUNAR ORBIT
8. COAST IN LUNAR ORBIT
9. LM DESCENT
10. LM ASCENT
11. SM TRANSEARTH INJECTION BOOST
12. TRANSEARTH COAST
13. EARTH ATMOSPHERE REENTRY
14. TOUCHDOWN
15. S-IVB SLINGSHOT